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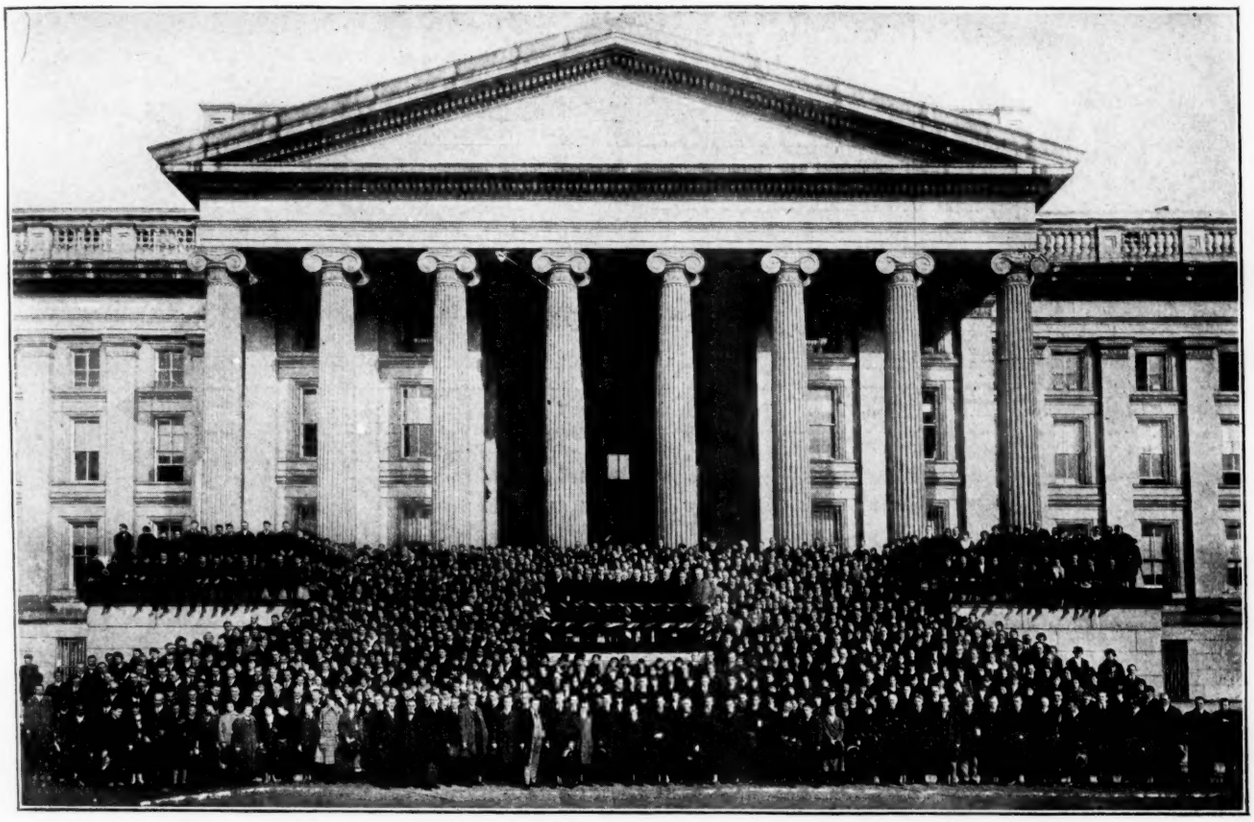

The United States Fuel Administration

HEREWITH is reproduced a photograph of the Washington personnel of the United States Fuel Administration, or as much of it as could be gotten together on Tuesday, Nov. 12, when the picture was taken. This organization, established by the President under the Lever Act, for the purpose of controlling the production, distribution and use of the fuel so essential to the prosecution of the war and to the maintenance of industry, transportation, health and comfort, enlisted the services of thousands of persons throughout the country under the leadership of Dr. Harry A. Garfield. It is impossible to state the full measure of its accomplishments, for no one can estimate the degree of scarcity, deprivation and extortion to which the country might have been subjected without its activities. It can be said, however, that while in all the other countries that were at war the production of coal fell off most seriously, production in the United States, notwithstanding the excessive demands on our man power, the difficulty of getting machinery, supplies and energy, and the overworked condition of our railways, has been increased a hundred million tons per annum, or over 20 per cent., and savings in various uses have been effected, of some 12,000,000 tons per annum, 3,500,000 having been saved in six months in the power-plant industries and 500,000 tons on the railroads.

The initial stress had to be put upon volume of output and economy in use. Prices had to be allowed which stimulated production. Even these were exceeded by various subterfuges, and quantities of slate and rock unloaded upon the public at the enhanced price of coal lumbered up the already congested railways. The Administration has now, however, detailed information of the cost of production, a system of inspection as to quality, and the power and disposition, if not the facility, to insure that the producers shall furnish coal of a fair quality to the limit of their capacity and at a price which will yield them only a fair profit. Up to Nov. 18, 199 mines had been shut down for furnishing dirty coal. During the coal year 160,000,000 car-miles have been saved by the enforcement of the zone system, and this would allow 5 per cent. increase in production, which has for the most part been limited by car shortage.

In the direction of conservation the Fuel Administration has not only urged upon users the necessity of economy, but has incited in the managers of power plants an interest in the possibility of saving, and through bulletins, lectures, local committees and other means has pointed out to them the ways in which this could be effected. It is just beginning to realize upon its efforts in this direction, and as the movement gains impetus and its results become cumulative, the economies effected will be multiplied.

The United States Fuel Administration will terminate automatically upon the proclamation of peace, unless something shall have been done in the meantime to authorize its continuation. Is it not worth saving?

High Steam Pressure and Superheat*

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To improve steam-plant economy the author favors high pressures with sufficient superheat to reduce the condensation in the turbine to a practical minimum. With steam at 800 lb. pressure and 800 deg. F., it would be possible to produce a kilowatt-hour on 11,750 B.t.u.

IN DEVELOPING the steam turbine the designer has constantly had higher efficiency in view and in this respect has succeeded to the extent that today turbines are in operation having a thermodynamic efficiency of almost 90 per cent. While this already high efficiency may be improved by a small percentage in the future, it will be necessary to look to other parts of the power plant for substantial gains in fuel economy. Such gains can be made by increasing the temperature range of the steam, but as the lower range is fixed by the temperature of the cooling water, the gain must be made by going to a higher initial temperature. This can be accomplished by the use of higher steam pressure, by the application of superheat or by a combination of both.

The thermodynamic or Rankine-cycle efficiency of a turbine is the ratio of the mechanical energy taken out of the steam by the turbine to the total energy in the supplied steam when this steam is expanded adiabatically from the pressure at the throttle valve to the exhaust pressure in the turbine casing. Adiabatic expansion takes place when the lowering of the temperature of the steam is done entirely by extraction of work from the steam.

When connected to an electric generator, the steam consumption of a turbine is generally stated in pounds of steam per kilowatt-hour, and is the amount of steam required to deliver one kilowatt of electrical energy for one hour. "Theoretical water rate" is a term generally used in all turbine investigation and is the ratio of one kilowatt-hour expressed in foot-pounds (2,654,000) to the available energy in one pound of steam expressed in foot-pounds. The ratio therefore between the theoretical water rate and the actual measured water rate gives the efficiency. When the turbine is connected to an electric generator, the combined efficiency of turbine and generator is generally given. Table I gives the theoretical water rates per kilowatt-hour at the steam pressures, superheats and vacua generally used. It will furnish a convenient reference from which the efficiency of any particular machine may be determined.

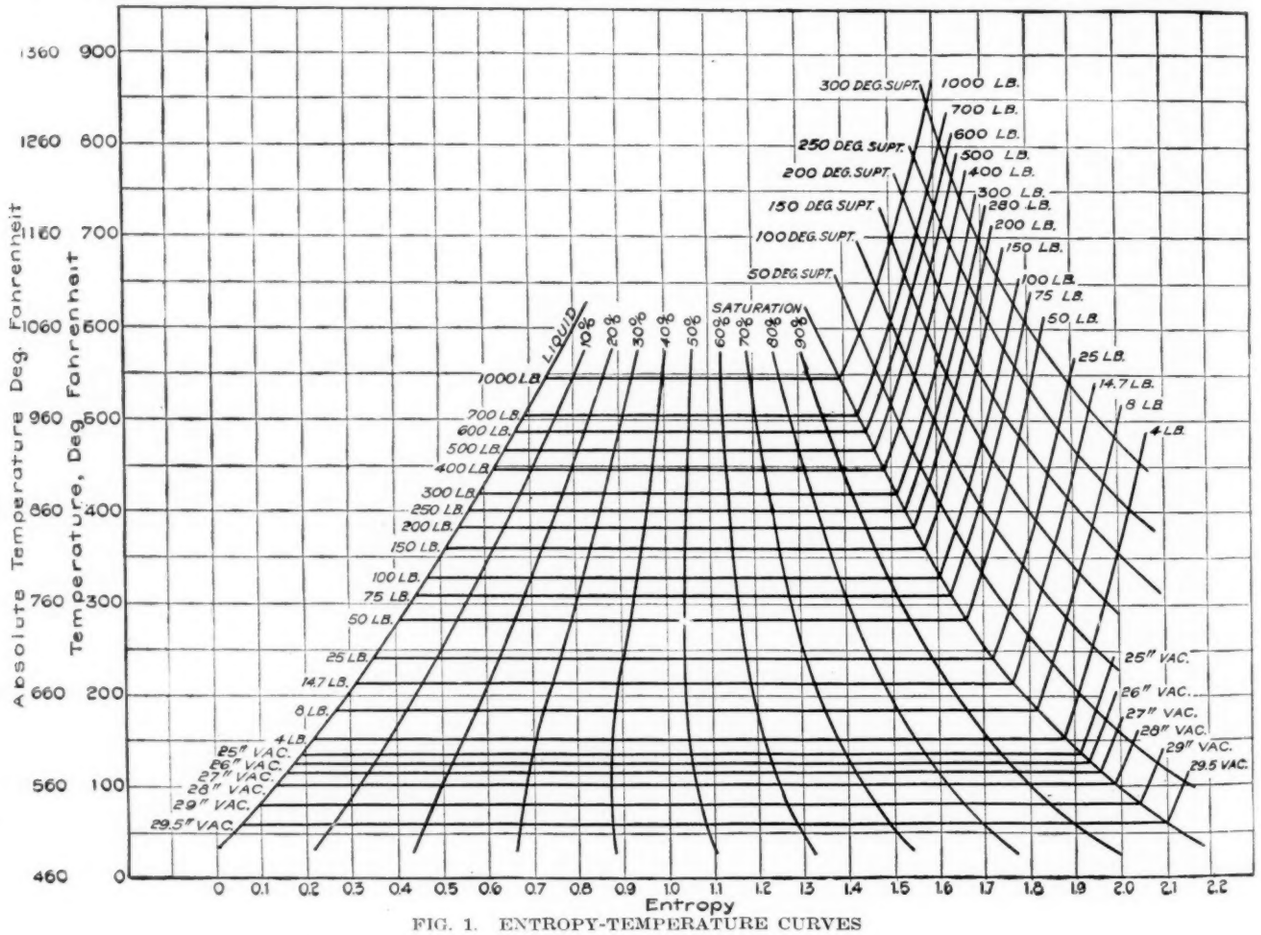


FIG. 1. ENTROPY-TEMPERATURE CURVES

*Abstract of paper read before joint meeting of Western Society of Engineers and the Chicago Sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

The theoretical gain obtainable by the use of higher steam pressures is illustrated in Table II, in which case 1 lb. of dry steam at 200 lb. pressure expanded to 28½ in. of vacuum is considered unity. It will be seen that by raising the boiler pressure to 500 lb. there is a saving in fuel of 14.43 per cent. In money this saving

TABLE I—THEORETICAL WATER RATES PER KW.-HOUR
(Heat Values from Marks & Davis' Steam Tables)

Suphr. Deg. F.	150 LB. GAUGE						160 LB. GAUGE					
	26 in.	27 in.	27.5 in.	28 in.	28.5 in.	29 in.	26 in.	27 in.	27.5 in.	28 in.	28.5 in.	29 in.
0	11.80	11.23	10.92	10.55	10.12	9.59	11.66	11.10	10.79	10.43	10.01	9.50
25	11.61	11.05	10.74	10.38	9.96	9.44	11.45	10.91	10.61	10.26	9.85	9.34
50	11.42	10.87	10.58	10.22	9.81	9.30	11.28	10.75	10.45	10.11	9.70	9.21
75	11.24	10.71	10.41	10.07	9.66	9.17	11.10	10.58	10.29	9.95	9.56	9.07
100	11.07	10.55	10.26	9.92	9.52	9.03	10.92	10.41	10.13	9.80	9.42	8.94
125	10.90	10.38	10.10	9.77	9.38	8.90	10.75	10.25	9.98	9.66	9.27	8.81
150	10.75	10.23	9.96	9.63	9.25	8.78	10.60	10.10	9.84	9.52	9.15	8.69
	165 LB. GAUGE						170 LB. GAUGE					
0	11.57	11.03	10.73	10.37	9.96	9.45	11.50	10.96	10.66	10.32	9.91	9.40
25	11.39	10.84	10.55	10.20	9.80	9.30	11.31	10.78	10.49	10.15	9.75	9.25
50	11.20	10.68	10.39	10.05	9.65	9.16	11.13	10.61	10.33	9.99	9.60	9.11
75	11.02	10.50	10.22	9.89	9.50	9.02	10.95	10.45	10.17	9.84	9.45	8.98
100	10.85	10.35	10.08	9.75	9.37	8.89	10.79	10.29	10.02	9.70	9.32	8.85
125	10.68	10.18	9.92	9.60	9.23	8.76	10.62	10.13	9.86	9.55	9.18	8.73
150	10.52	10.04	9.77	9.46	9.10	8.64	10.47	9.99	9.73	9.42	9.05	8.60
	175 LB. GAUGE						180 LB. GAUGE					
0	11.44	10.91	10.61	10.27	9.87	9.36	11.37	10.85	10.56	10.22	9.82	9.31
25	11.25	10.72	10.44	10.10	9.70	9.21	11.18	10.67	10.38	10.05	9.66	9.17
50	11.07	10.55	10.27	9.94	9.55	9.07	11.01	10.50	10.22	9.89	9.51	9.03
75	10.89	10.39	10.11	9.79	9.41	8.94	10.83	10.34	10.06	9.74	9.37	8.90
100	10.72	10.23	9.96	9.64	9.27	8.81	10.66	10.17	9.90	9.60	9.22	8.77
125	10.55	10.07	9.81	9.50	9.13	8.68	10.49	10.02	9.76	9.46	9.09	8.65
150	10.40	9.92	9.67	9.37	9.00	8.56	10.34	9.87	9.61	9.32	8.96	8.52
	185 LB. GAUGE						190 LB. GAUGE					
0	11.31	10.79	10.51	10.17	9.77	9.28	11.25	10.74	10.46	10.12	9.73	9.25
25	11.12	10.61	10.33	10.00	9.61	9.13	11.06	10.56	10.28	9.96	9.58	9.10
50	10.94	10.44	10.17	9.84	9.46	8.99	10.88	10.39	10.12	9.80	9.42	8.96
75	10.77	10.28	10.02	9.69	9.32	8.86	10.71	10.23	9.97	9.65	9.28	8.82
100	10.60	10.12	9.86	9.55	9.19	8.73	10.55	10.08	9.82	9.51	9.15	8.70
125	10.43	9.97	9.72	9.41	9.05	8.61	10.39	9.92	9.67	9.37	9.01	8.58
150	10.28	9.82	9.57	9.27	8.92	8.49	10.23	9.77	9.53	9.24	8.88	8.46
	195 LB. GAUGE						200 LB. GAUGE					
0	11.20	10.69	10.41	10.08	9.69	9.22	11.15	10.64	10.37	10.04	9.66	9.18
25	11.01	10.51	10.24	9.92	9.53	9.07	10.95	10.46	10.19	9.87	9.49	9.03
50	10.83	10.35	10.08	9.76	9.38	8.92	10.77	10.29	10.03	9.71	9.34	8.88
75	10.66	10.18	9.92	9.61	9.24	8.79	10.61	10.13	9.87	9.57	9.20	8.75
100	10.50	10.03	9.77	9.47	9.11	8.66	10.44	9.97	9.72	9.42	9.06	8.62
125	10.33	9.87	9.62	9.32	8.97	8.54	10.28	9.83	9.58	9.28	8.93	8.50
150	10.18	9.72	9.48	9.18	8.84	8.42	10.13	9.68	9.44	9.15	8.81	8.38
200	9.86	9.43	9.19	8.92	8.59	8.18	9.81	9.39	9.15	8.88	8.55	8.15
	205 LB. GAUGE						210 LB. GAUGE					
0	11.09	10.60	10.32	9.99	9.62	9.15	11.04	10.55	10.28	9.97	9.59	9.12
25	10.90	10.41	10.14	9.82	9.45	8.99	10.85	10.37	10.10	9.79	9.42	8.96
50	10.72	10.24	9.98	9.67	9.30	8.85	10.68	10.20	9.94	9.63	9.27	8.82
75	10.55	10.09	9.83	9.52	9.17	8.72	10.50	10.04	9.78	9.48	9.13	8.69
100	10.39	9.93	9.68	9.38	9.03	8.59	10.34	9.89	9.63	9.34	9.00	8.56
125	10.23	9.78	9.54	9.24	8.90	8.47	10.19	9.75	9.49	9.21	8.87	8.44
150	10.08	9.64	9.39	9.11	8.77	8.35	10.03	9.60	9.35	9.07	8.74	8.32
200	9.77	9.35	9.11	8.84	8.52	8.12	9.73	9.31	9.08	8.81	8.49	8.10
	215 LB. GAUGE						220 LB. GAUGE					
0	11.00	10.51	10.24	9.93	9.55	9.09	10.95	10.47	10.20	9.89	9.52	9.06
25	10.79	10.32	10.05	9.75	9.38	8.93	10.75	10.28	10.02	9.71	9.35	8.90
50	10.62	10.16	9.89	9.59	9.24	8.79	10.58	10.11	9.85	9.55	9.20	8.76
75	10.46	10.00	9.74	9.44	9.09	8.66	10.41	9.95	9.70	9.40	9.06	8.63
100	10.30	9.85	9.60	9.30	8.96	8.53	10.24	9.80	9.55	9.26	8.93	8.50
125	10.14	9.70	9.46	9.16	8.83	8.41	10.03	9.66	9.42	9.13	8.80	8.38
150	9.98	9.55	9.31	9.03	8.71	8.29	9.94	9.52	9.28	9.00	8.67	8.27
200	9.68	9.27	9.04	8.77	8.46	8.06	9.64	9.23	9.00	8.74	8.42	8.03
	225 LB. GAUGE						230 LB. GAUGE					
0	10.90	10.42	10.16	9.85	9.48	9.03	10.86	10.39	10.12	9.82	9.45	9.00
25	10.71	10.24	9.98	9.67	9.32	8.87	10.66	10.20	9.94	9.64	9.28	8.84
50	10.53	10.07	9.81	9.52	9.17	8.73	10.48	10.03	9.78	9.48	9.13	8.70
75	10.36	9.91	9.66	9.37	9.03	8.60	10.32	9.87	9.63	9.34	8.99	8.57
100	10.20	9.76	9.52	9.23	8.90	8.47	10.16	9.72	9.48	9.70	8.86	8.45
125	10.05	9.62	9.38	9.10	8.77	8.35	10.01	9.58	9.34	9.06	8.74	8.33
150	9.90	9.47	9.24	8.96	8.64	8.23	9.85	9.44	9.20	8.93	8.61	8.21
200	9.60	9.20	8.97	8.71	8.40	8.01	9.56	9.16	8.93	8.67	8.37	7.98
	235 LB. GAUGE						240 LB. GAUGE					
0	10.81	10.35	10.09	9.78	9.42	8.96	10.76	10.31	10.05	9.75	9.39	8.94
25	10.61	10.15	9.90	9.60	9.25	8.81	10.57	10.12	9.86	9.57	9.22	8.78
50	10.44	9.99	9.75	9.45	9.10	8.67	10.38	9.95	9.70	9.41	9.07	8.64
75	10.27	9.83	9.59	9.30	8.96	8.54	10.23	9.79	9.55	9.26	8.93	8.51
100	10.12	9.68	9.45	9.17	8.83	8.42	10.08	9.65	9.41	9.13	8.80	8.39
125	9.96	9.54	9.30	9.03	8.70	8.29	9.92	9.50	9.27	9.00	8.67	8.27
150	9.81	9.40	9.16	8.90	8.58	8.18	9.97	9.36	9.13	8.86	8.55	8.15
200	9.52	9.12	8.90	8.64	8.33	7.95	9.48	9.09	8.87	8.61	8.31	7.93
	245 LB. GAUGE						250 LB. GAUGE					
0	10.73	10.27	10.01	9.71	9.35	8.91	10.69	10.23	9.98	9.68	9.33	8.89
25	10.53	10.08	9.83	9.53	9.18	8.75	10.49	10.04	9.79	9.49	9.15	8.72
50	10.35	9.91	9.67	9.38	9.04	8.61	10.31	9.87	9.63	9.34	9.01	8.59
75	10.19	9.76	9.52	9.23	8.90	8.48	10.15	9.72	9.48	9.20	8.87	8.46
100	10.03	9.61	9.37	9.09	8.77	8.36	9.99	9.57	9.34	9.07	8.74	8.34
125	9.88	9.47	9.23	8.96	8.64	8.24	9.84	9.43	9.20	8.93	8.61	8.22
150	9.73	9.33	9.10	8.83	8.52	8.12	9.69	9.29	9.06	8.80	8.49	8.10
200	9.43	9.04	8.82	8.57	8.27	7.90	9.41	9.02	8.80	8.55	8.25	7.88

would amount to about $200,000 a year in a plant burning about 900 tons a day with coal at $5 a ton.

Table III shows the theoretical gain by superheat. The table is calculated on the basis of an initial pressure of 250 lb. gage expanded to a 29-in. vacuum. It will be seen that the theoretical gain is small, being only 2.9 per cent. when superheating up to 300 deg. To this, however, must be added the practical benefit of using superheat. This is often expressed by saying that the water rate is reduced 1 per cent. for a certain number of degrees of superheat. The amount of this decrease varies with turbines of different design, but a figure frequently used is 1 per cent. gain in water rate for every 12.5 deg. increase of superheat. Column 5, Table III, is based upon this assumption. The actual net gain of fuel in percentage is therefore shown by column 8, which is the difference between column 7 and column 4. The practical gain by superheat is about two and one-half times as great as the theoretical, the reason being that in a well-designed turbine of, say, the impulse type, the magnitude of the total losses is about the following proportions when dry initial steam is used:

	Per Cent.
Loss due to friction in nozzles and blades and windage loss of disks and blades	20
Leakage loss	3
Rejected energy (due to residual steam velocity)	3
Bearings, packing, etc	1
Total losses	27
Efficiency of turbine	73

From the preceding table it may be seen that the first item is by far the most important, and it is this

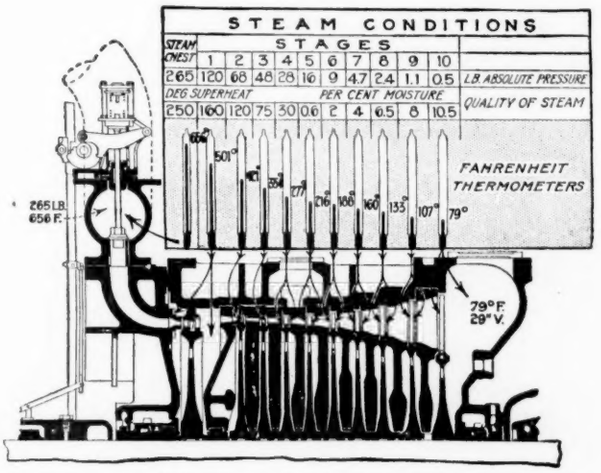


FIG. 2. SECTION OF TEN-STAGE TURBINE, SHOWING CONDITIONS OF STEAM IN EACH STAGE

one that is reduced by the use of superheat. The use of 2000 deg. superheat will reduce the friction and windage loss about one-quarter, or to 15 per cent., and the total loss would then be 22 per cent., making the turbine efficiency 78 per cent. This reduction is effected by the superheat reducing the moisture in all the stages. The reduction is best shown by the entropy-temperature diagram Fig. 1. From this diagram it may be seen that starting with dry steam at 265 lb. absolute pressure and expanding it adiabatically to 29 in. vacuum through a turbine of 100 per cent. efficiency would result in steam of about 26.5 per cent. moisture, whereas if the steam had been superheated to, say, 250 deg. this moisture would be reduced to about 19 per cent., a reduction of almost 30 per cent. In an actual turbine this percentage of moisture is a great deal lower, the amount depending upon the efficiency.

Fig. 2 shows a cross-section of a turbine having ten stages and gives approximately the condition of the steam in all the stages, assuming the turbine has 80 per cent. efficiency, is supplied with steam at 250 lb. gage pressure, 250 deg. superheat, and is exhausting into 29-in. vacuum. Table IV gives a comparison of

the steam condition in this turbine had the steam been initially dry.

For determining the effect of moisture on friction a great many formulas and curves are given by various authors, based on experimental and theoretical data, and they all have a constant that varies according to the conditions of the steam. Professor Moyer, for example, in his book on steam turbines, gives a formula for rotation losses of buckets and wheel disks in which the constant is as follows:

	Constant
100 deg. superheat	0.875
50 deg. superheat	0.93
0 deg. superheat	1.00
5 per cent. moisture	1.08
10 per cent. moisture	1.25
20 per cent. moisture	2.00

In other words, the friction loss is twice as great with 20 per cent. moisture as it is with dry steam.

Throttling of dry steam always produces superheat, and it has often been said for this reason that there is practically no loss due to throttling, which is true as far as heat is concerned. There is, however, a considerable loss of available energy. The amount of superheat obtained by throttling is easily calculated because the total heat before and after throttling is the same. Assume that steam at 200 lb. absolute pressure is throttled down to 100 lb. absolute pressure. The total heat in dry steam at 200 lb. abs. = 1198.1 and that at 100 lb. abs. = 1186.3. If the specific heat of steam

TABLE II. THEORETICAL GAIN IN FUEL BY INCREASING STEAM PRESSURE

Absolute Pressure, Lb.	Corresponding Temperature, Deg. Fahr.	Total Heat	Increase in Total Heat, Per Cent.	Available Energy in Ft.-Lb. Expanding to 28.5 in Vacuum	Increase of Available Energy, Per Cent.	Net Gain in Fuel, Per Cent
200	381.9	1198.5	....	272,000	....	.....
300	417.5	1201.9	0.28	293,000	7.72	7.44
400	444.8	1202.5	0.33	304,500	11.95	11.62
500	467.2	1201.7	0.27	312,000	14.7	14.43
600	486.5	1199.8	0.11	319,000	17.2	17.09
700	503.4	1197.4	0.902	323,000	18.7	18.79
800	518.5	1194.4	—0.342	327,000	20.2	20.54
900	532.3	1191.1	—0.617	329,000	20.9	21.51
1000	545.0	1187.6	—0.909	331,000	21.7	22.6

is taken as 0.5, then $1198.1 = 1186.3 + (0.5 \times t)$ in which t, the superheat, = 23.6 deg. The available energy, however, assuming that the steam in both cases is expanded to 28.5 in. vacuum, is, with 200 lb. pressure and dry steam, 270,800 ft.-lb. and, with 100-lb. pressure and 23.6 deg. superheat, 240,200 ft.-lb., or a loss in available energy of about 11 per cent.

High steam pressure with no superheat has the disadvantage, as may be seen from an entropy diagram, of producing more moisture through the turbine. It is therefore advisable to combine high pressure with superheat so as to produce a more efficient turbine.

Fig. 3 shows the ratio of available British thermal units in steam to the total heat in the steam, with feed water at a temperature of 90 deg.. The present practice in power plants in this country is to use, with turbine drive, a steam pressure of 200 lb. gage, 150 deg. superheat (temperature of 538 deg.) and a vacuum of 28.5 in. With these conditions as to steam pressure and superheat, the ratio of maximum available heat for work to the total heat is only about 31.25 per cent. In Europe, however, steam temperatures as high as 700 deg. F. are now used (corresponding to a steam pressure of 500 lb. and 233 deg. superheat), so the ratio of available heat is about 36.33 per cent. there. This permits a fuel saving of 16 per cent. compared with conditions in this country.

Turbine-generator sets are now built having an overall efficiency of more than 80 per cent., including generator losses, which with a boiler efficiency of 80 per cent. would give an efficiency from fuel amounting to $36.33 \times 0.80 \times 0.80 = 23.25$ per cent. Since 1 kw.-hr. = 3412 B.t.u., the B.t.u. required to produce 1 kw.-hr. at the switchboard = $3412 \div 0.2325 = 14{,}675$. On the other hand, if 800 lb. pressure and 800 deg. temperature are used, the efficiency will be 38.75 per cent.; so that with a turbine efficiency of 85 per cent. and a boiler

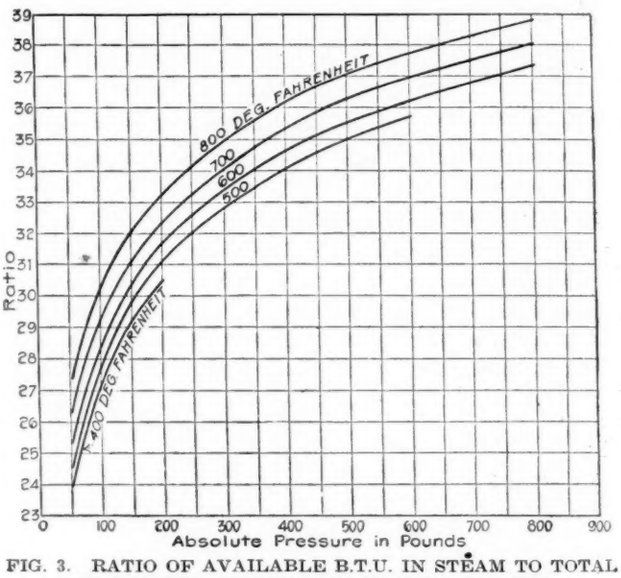


FIG. 3. RATIO OF AVAILABLE B.T.U. IN STEAM TO TOTAL HEAT IN STEAM AND FEED WATER AT 90 DEG. TEMPERATURE

efficiency of 88 per cent. (obtainable with liquid fuel, forced draft and preheated combustion air) a kilowatt-hour could be obtained on $38.75 \times 0.88 \times 0.85 = 29$ per cent. or $3412 \div 0.29 = 11{,}750$ B.t.u. This is equivalent to $11{,}750 \div 19{,}000 = 0.62$ lb. of fuel oil per kilowatt-hour.

Diesel-engine advocates now claim about 0.55 lb. of fuel oil per kilowatt-hour, but this is obtained only with a fuel about 50 per cent. higher in price than that which can be satisfactorily burned under a boiler. It may thus be seen that when full advantage has been taken of the various processes that are used in transforming the energy of the fuel into mechanical energy through the medium of steam the steam process compares quite favorably with results obtained at the present time with internal-combustion engines.

TABLE III. EFFECT OF SUPERHEATING STEAM WHEN WORKING BETWEEN 250 LB. GAGE AND 29 IN. OF VACUUM

Degree Superheat	Temperature, Deg. Fahr.	Total Available Energy Per Lb. of Steam	Total B.t.u. Per Lb.	Per Cent. Increase in Coal to Produce Superheat	Per Cent. Increase Available Energy Due to Superheat	Net Theoretical Gain, Per Cent.	Actual Gain, Per Cent.	Actual Net Gain, Per Cent.
(1)		(2)	(3)	(4)	(5)	(6) = (5—4)	(7)	(8) = (7—4)
0	406	298,000	1202.3	....	....	....	....	....
50	456	308,500	1237.0	2.89	3.53	0.64	4.00	1.11
100	506	318,000	1264.6	5.18	6.72	1.54	8.00	2.82
150	556	327,500	1290.5	7.33	9.90	2.57	12.00	4.67
200	606	336,000	1315.6	9.45	12.75	3.30	16.00	6.55
250	656	341,500	1340.5	11.50	14.60	3.10	20.00	8.50
300	706	347,000	1365.3	13.55	16.45	2.90	24.00	10.45

In the discussion questions arose as to the practicability of obtaining piping and equipment that will withstand higher pressures and superheats, whether the increased cost of the equipment will keep pace with the gain in economy, the probability of higher radiation losses, the possibility of superheat high enough to give dry steam at the turbine exhaust, the possible advantages of re-superheating the steam for the lower stages with the waste heat from the boilers, and the interference of economizers in obtaining the theoretical advantages from higher pressures and superheat.

To show that the design of equipment for the higher pressures mentioned is not impracticable, the author referred to the case of De Laval, in 1917, supplying all the electrical energy for lighting the Exposition of Arts and Industries in Stockholm with turbo-generating sets operated from boilers of his own design using over 1500 lb. pressure. Of course the units were small, four being rated at 100 hp. and two at 50 hp. each.

TABLE IV. QUALITY OF STEAM IN TEN STAGES OF A TURBINE, STARTING WITH DRY STEAM SUPERHEATED 250 DEG.

	Stages									
Quality of Steam	1	2	3	4	5	6	7	8	9	10
Dry initial, per cent. moisture	4.4	6.8	8.15	9.8	11.5	13	14.5	16.0	17.3	18.7
250 Deg. Superheat:										
Deg. superheat	160.0	120.0	75.0	30.0	....	..	....	....	....	....
Per cent. moisture	.....	.....	.....	....	0.6	2	4.0	6.5	8.0	10.5

To get dry steam at the exhaust in the average turbine would require excessive superheat. Enough superheat to reduce the moisture to 5 or 6 per cent. at the turbine exhaust is about the practical limit.

The author holds that the cost of high-pressure equipment will be less than that of present equipment. This applies particularly to the boiler. Smaller tubes can be used, say of 1-in. (2.54-cm.) diameter, and the boiler can be smaller, lighter and cheaper than boilers carrying the lower pressures of today. All auxiliaries would have to be redesigned, and it would probably be best to eliminate joints and weld the piping system solid.

There would be a little more moisture from condensation at the casing. The use of the flue gases for re-superheating the steam for the lower stages would necessitate splitting the turbine into two elements, so that the residual velocity would be lost, causing a drop of 5 or 6 per cent. in efficiency. It would also introduce undesirable complications. However, there might be a gain in using an oil-fired superheater for the purpose, allowing the gases to pass into the boiler.

Putting an Engine on the Dock

BY L. K. ELLSWORTH

The following incident occurred at one of Uncle Sam's naval basins on the Atlantic Coast. The officer in charge of repairs ordered Buntline, the chief machinist's mate, to remove the steering gear of the seagoing tug onto the dock, as it required a shop overhauling. The engine was to be on the dock by 5 p.m., ready for the night force to work on. Buntline was instructed to call on the officer of the deck if he needed help, but whatever happened not to hold the night men up.

Butline and his helper got busy, and a short time sufficed to disconnect the flange couplings and the foundation bolts. Then Buntline hunted up the officer of the deck and said:

"Sir, it is the orders of my engineering officer that I ask you for help to put the steering engine on the dock."

It was a matter of much concern when Buntline heard the officer of the deck shout, "Liberty party on deck." Then, addressing the men who had been busy making preparations to spend the evening on shore, he said: "No man rating liberty leaves this ship until this man's orders are carried out."

Buntline realized that the men who were to do his bidding were in no mood to be handled otherwise than with tact and diplomacy. He also knew that to curtail a sailor's liberty aboard ship, especially after a long cruise, and thus upset the anticipation of freedom from naval discipline, is indeed irritating. But orders were orders and the men soon assembled at the door of the 6 x 10 engine room.

"Say, Chief," bawled out one with fire in his eye, "what do yer think we are aboard this madhouse, a lot of mules? Have we got to lug that heap of junk outer this rat hole, carry it clean forward and hist it onter the dock? Well, it can't be done! You can tell the whole world that for me."

"Why, that O. D. must be dizzy," returned a husky redhead who had not quite finished shaving. "Don't he know the tide is ebb and we've got a three-foot lift to the dock?"

"A three-foot lift nothing," interrupted a fellow called Sunny. "What do yer think that boom engine forwards is for? Did ye think we'd carry that engine for a moment? That shows what you deck gobs know about machinery."

"Why, you rip roaring son of a sea cook, you can't run that engine without steam," growled Red, "and we dumped fires and blew down no sooner than we lashed fast to the dock."

"Now here, buddies, this mud slinging ain't gon'a carry out these orders," interrupted Buntline. "You may as well get onto the job. I ain't stuck on being here any more than you are, and my time is up at 5 o'clock; so let's sail in and we'll all shove off mighty close to that hour."

"Right'o, boys," came the chorus, and Buntline's countenance radiated a smile, for he realized that he had won the first and most important point, their confidence.

"Now, fellers," continued Buntline, "this machine must be upended to clear the door sill, then in that position we'll bring it clear on a swing. Now, Sunny, put a hitch on that beam under the deck for the block and fall, and Smith with that chain block lift high. Now, boys, all the beef you've got and heave-to on that rope. Then Smith will slack away."

This arrangement worked as calculated, carrying the engine free of the door like a breeches buoy, to the main deck.

The vessel was a seagoing tug and equipped with a set of tracks running fore and aft on both starboard and port sides; so much for their convenience. On these tracks the engine was landed flat on its bedplate.

"Now," ordered Buntline, "take that block and fall forward, make fast to that starboard bitt and we won't be long speeding her forward."

Buntline's prophecies were soon fulfilled, but the boys saw the dim vision of their approaching liberty fade as the problem of getting the engine athwartship dawned on them.

"We are sure out of luck, now, shipmates," growled one, voicing the pessimistic sentiments of the crew.

But not so with Buntline. He did not waste his time brooding over anticipated failures. He had been thinking, and when the engine was in the right position, ordered:

"Now one of you fellers unhitch that block and fall, make it fast to that outboard dock bitt, and you, Red, unhitch that section of track. She'll come clear by unbolting those fishplates, then we'll skid the engine, track and all, across the deck."

"Good stunt," shouted Monahan, who until this time was in deep dejection. The orders were followed out and, as if equipped with ball-bearing rollers, the engine soon lay alongside the dock.

Buntline lost no time in issuing his next order. "A couple of you fellers tumble aft and bring those two planks forward. Also the chain blocks."

The required paraphernalia was soon on hand and Buntline's next orders were:

"Now hook the chain falls on the bitt with the block and fall and then all stand by for a big lift. Now, all together for a big heave and up she goes. Push the planks well under."

Then, with the aid of a few rollers and the good-will of the gang, the engine was put on the dock just as the night crew arrived with the truck, to be greeted with a loud hurrah from the boys.

The best of spirits were now manifest as the crew stood by for final orders. Then Buntline, with a pleasant gleam in his eyes, remarked; "Boys, you sure do rate liberty. Now, it's just 5 minutes past 5; shove off and good luck!"

"All right, chief," returned Monahan enthusiastically, "any time you need a hand, liberty or no liberty, count on this crew."

The Way They Go

Through the courtesy of G. A. Hoffman, chief engineer of the Baden Station of the St. Louis City Water Works, the accompanying illustration is shown of a boiler tube which split open at his plant while in service. The length of the opening is 52 in., and Mr. Hoffman believes it to be the longest split of its kind on record.

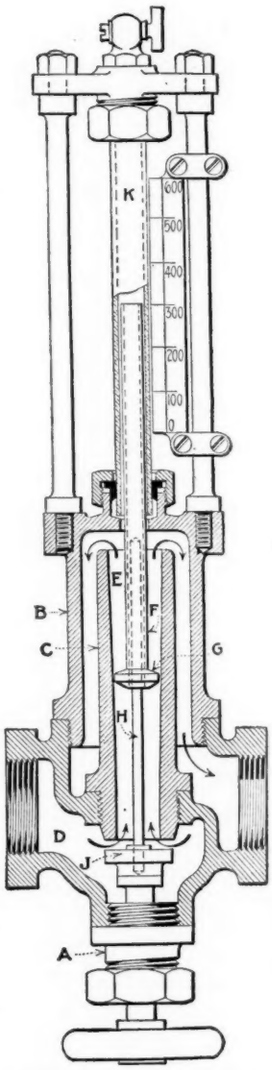
SPLIT IN BOILER TUBE 52 IN. LONG

Before putting the boiler under steam it was given a cold-water test of 150 lb. pressure, and so far as could be determined it was in good condition. An hour and a half after steam was raised to the working pressure, the tube failed. According to the boiler-room foreman the steam gage registered 150 lb. at the time, and nothing unusual preceded the accident. The tube had been in service about 20 years; it opened along the seam.

Edlich Flow-Indicating Valve

In power-plant practice the general method of measuring fluid passing through a pipe is by means of a meter of one type or another. It is evident that if a combination of meter and valve were made, the pressure or velocity indication of liquid would be simplified. With that idea in mind, Paul Edlich, 134 Main Ave., Passaic, N. J., has patented the Edlich flow-indicating valve, a vertical section of which is shown in the illustration.

The object of this device is to provide a measuring and indicating apparatus for liquids in which the pressure or velocity of the fluid passing through the valve can be accurately determined. The valve casting is provided with the usual inlet and outlet passages. The bottom of the valve body is provided with a plug *A*, through which the valve stem operates. Into the top part of the valve is screwed a hollow cylinder *B*, the interior of which communicates with the outlet of the valve body. Located within the hollow cylinder is an inverted conical-shaped body *C*, the lower end of which opens to the inlet passage *D* in the valve. The lower end of this conical body is so formed as to provide a valve seat. The body *C* is made with an inverted conical-shaped passage *E*, in which is mounted a sliding tubular indicating element F, the lower end of which is provided with a piston head *G*, which has a central opening that communicates with the interior of the indicating element, and extending through the opening in the piston head *G* and into the tubular indicating element *F* is the upper end of a guide rod *H*, the lower end of which is inserted into a valve disk *J* and which is operated by means of the hand-wheel below the plug *A*. A gage-glass *K* is placed above the upper end of the hollow body *B*, with an adjoining graduated gage plate, as shown.



SECTION THROUGH INDICATING VALVE

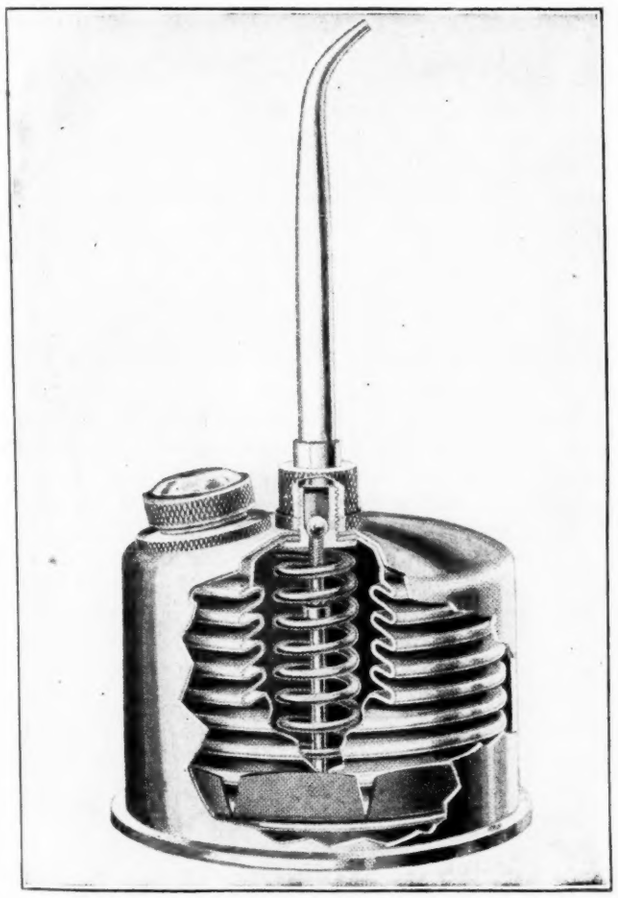
When the valve disk *J* is closed, the indicating element *F* will be at its lowest position, or zero. When the valve disk is moved to the open position, a pressure of the fluid against the lower face of the piston head *G* will force the piston and the indicating element *F* upward in the gage glass, and as the pressure of the liquid increases, the piston head and the indicating element will move upward in proportion to the amount of

pressure, and by virtue of the graduations on the plate the pressure of the liquid against the piston head can be determined.

The liquid, in passing through the conical-shaped passage *E*, is discharged through the upper end of the passage into the space between the body *C* and the inner surface of the cylinder body *B*, as indicated by the arrows, and is then discharged through the discharge passage in the valve body.

The Sylphon Oiler

One of the inherent faults of the ordinary oil can is that the spring bottom becomes set, and when in that condition oil cannot flow from the nozzle excepting by gravity. Another feature of the ordinary oil can is that a large amount of oil can be ejected at one



SHOWING DETAILS OF THE SYLPHON OILER

pressure on the bottom of the can. Thus usually more oil is discharged from the nozzle than is required for the part that is to be lubricated. In the Sylphon oiler the ordinary spring bottom is displaced by a brass bellows the folds of which permit of sufficient contraction effort to eject oil out of the nozzle of the oiler.

The illustration shows a semisectional view of this oiler, which is manufactured by the Fulton Co., Knoxville, Tenn. The body is of heavy steel, and as it is united by special locking methods, there are no soldered or brazed seams. A spring, as shown, keeps the bellows in an expanded position, and the excessive flow of oil from the nozzle is prevented by the ball check, which limits the amount that can be ejected at one contraction of the bellows, the inside of which forms the oil reservoir. The body of the oiler, which at present is made in pint size, is of heavy steel and serves to protect the bellows from injury.

Firing Low-Pressure Boilers

BY J. M. COLEMAN

Some years ago I got a job as fireman in one of our state institutions, on two 72-in. return-tubular boilers carrying 100 lb. of steam used for power and cooking. My mate had three similar low-pressure gravity-return heating boilers to care for, to which there was about 15 ft. fall from the basements of the buildings. In cool weather there usually was a "howl" for heat, which subsided almost immediately on my mate coming on watch. I would often notice 20 lb. pressure on the heating boilers when we came on duty, and as the safety valves were set for 25 lb. the night fireman would explain to my mate that "they wanted more heat but that is all they can get," which seemed reasonable, since he usually left very heavy bright fires and dampers wide open. Generally the water would be low in all three of the boilers and the feed on.

The first move my mate would make would be to shut the feed off the three boilers and check the fires, closing the damper on the boiler with the lowest water almost entirely. Straight away the water would begin to rise in all the boilers, but most rapidly in the one with the closed damper. After the water reached two gages in this one, he would open its damper and shut another one; when the water rose in this one in turn, he would open its damper and shut the one on the other boiler. He worked the dampers in this way during his watch, always keeping one of them almost shut regardless of the steam pressure, and he carried only from 5 to 10 lb. pressure in any weather. In less than an hour after coming on watch he would have the boilers flooded without using the feed valves and would have to blow down two or three times to rid the system of water, after which there would be no more calls for heat.

I was a novice at the business at the time and did not understand his system. When I asked him why the water came back for him and would not come back for the other fellow, he just smiled and said, "The water was mad at the other fellow." So it took me some time to get his "dope," but I got it at last and want to pass it along. His theory was that if you fire gravity-return boilers hard you create such a rapid circulation in the boilers that the return water will not be able to force the check valves open and pass through the pipe in the combustion chamber into the boiler. His plan was to keep one boiler fire checked at all times, permitting the return to enter that boiler without meeting the rapid circulation consequent to a live fire.

The tons of water he had to blow down to clear the system proved to me that he had the right "dope," but it was a standing mystery in that plant how he could heat all those buildings with from 5 to 10 lb., while others with heavy fires and 20 lb. failed repeatedly.

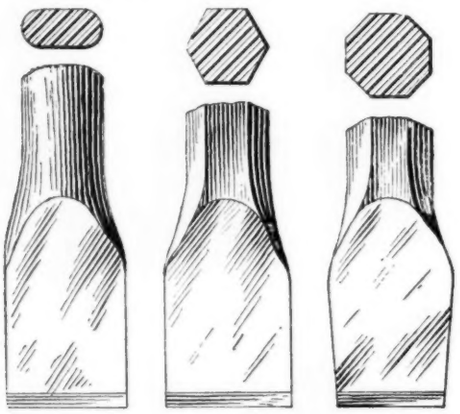
The Cold Chisel*

By J. A. LUCAS

This article shows that there are cold chisels and cold chisels. The shape of a chisel is determined by the work to be performed and the kind and texture of the material to be cut. It is important to keep both ends of a chisel in proper shape if best results are to be secured.

THE cold chisel is made from the three forms of steel shown in Figs. 1, 2 and 3. To make a chisel, a piece about 6½ in. long is first cut from the bar. One end is heated to a cherry-red heat and the head formed by slowly rotating the tool and hammering down the steel until the end becomes conical for a distance of about ⅝ in. The steel is then reversed, and after a heat about 1½ in. long has been made, the metal is drawn down to a wedge shape, care being taken to keep the edges from spreading.

It is important to note that the under side of the chisel lies flat on the anvil, and a flatter or smooth set-hammer should be used toward the end of the process



FIGS. 1 TO 3. VARIOUS TYPES OF ORDINARY COLD CHISELS

to smooth the work. If possible the chisel should be made in not more than two heatings, in order to maintain the original hardness in the steel. The finished forging should be allowed to cool off on the anvil while steady light hammer blows are struck upon it near the cutting edge. This operation renders more dense the molecular structure of the steel and greatly increases the life of the tool.

The chisel of ordinary size should measure between 8 and 9 in. over all, assuming that it is made from a bar of octagonal steel measuring ⅞ in. across the flats. The width of the tapered portion should not exceed 1 in., and the sides should be parallel for 2½ in. in a tool intended for general work, as shown in Fig. 2. For hard metal a chisel should be slightly tapered toward the point (Fig. 3), and for soft metals it should be bell shaped, as shown in Fig. 4. Soft metals are cut or chipped without lubrication, but wrought iron and steel yield far better results when the chisel edge is first rubbed on a piece of oily waste.

*From "Coal Age."

The cutting end of the chisel should be ground thin, as in that case it cuts both easier and smoother. The forged part should not exceed 2½ or 3 in. in length, as a long taper is highly conducive to springiness, whereas solidity is of importance both to rapid and smooth work. The facets forming the cutting edge should be straight throughout their widths, as at *B* in Fig. 6, and not rounded as at *A*. Straight faces permit the face next to the work to form a guide in holding the chisel at the proper angle to maintain the depth of the cut. This angle depends upon the nature of the material to be chipped. The more acute the angle the better the chisel will cut and the less will be the effort of raising the chip.

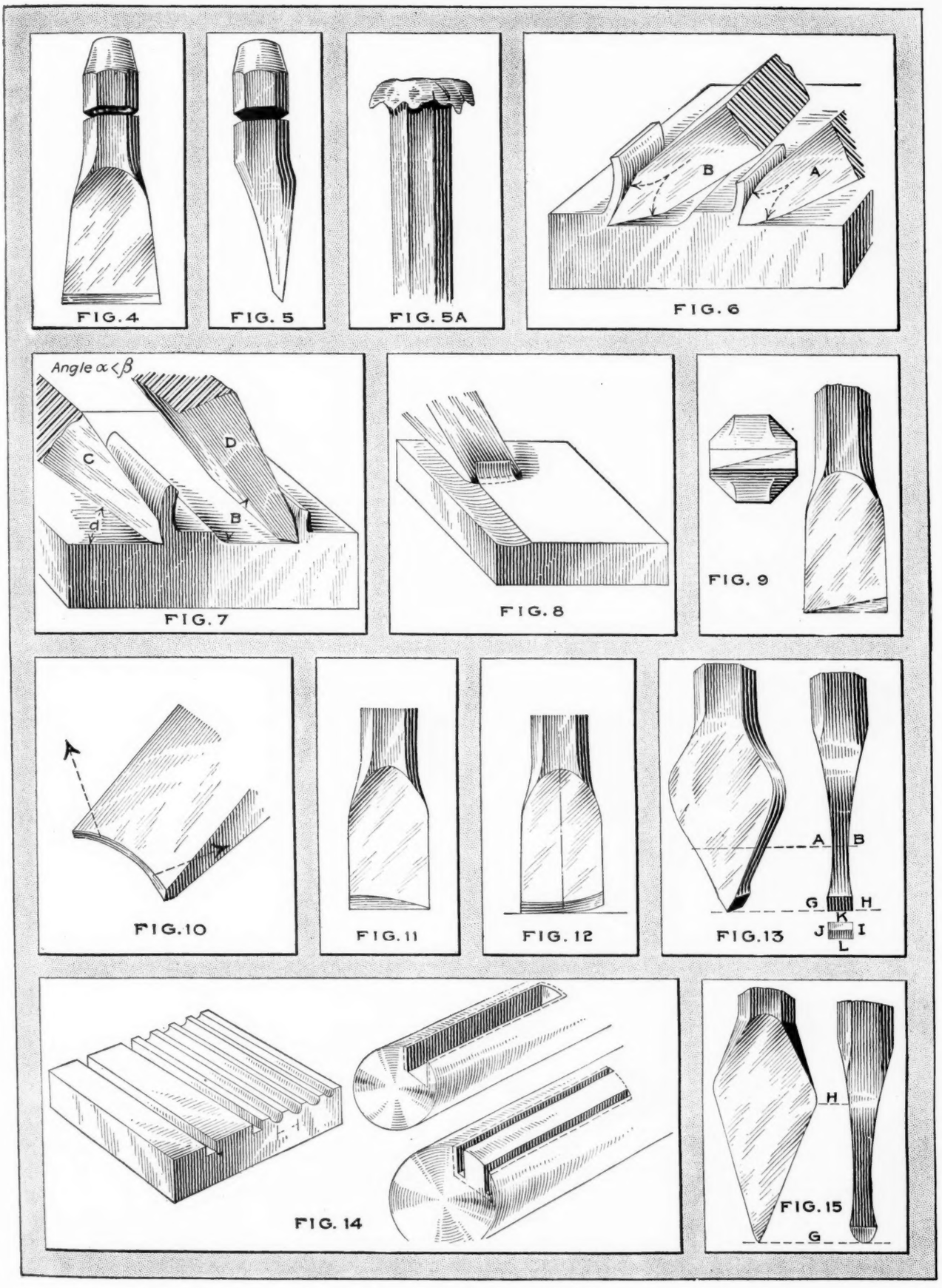
The cutting angle may safely be made 65 deg. for machine and other kinds of steel, 50 deg. for cast iron and brass, 30 to 35 deg. for copper, babbitt and lead.

The more acute these angles the nearer will the body of the chisel lie parallel with the work and the more effective will be the hammer blows. Thus in Fig. 7 the chisel *C* shows the position of the tool for wrought iron, while position *D* shows that for steel. The edge angle should always be made as acute as the hardness of the material will permit. If such an angle is too acute the cutting edge will be apt to bend, and if not sufficiently acute it will not cut keenly.

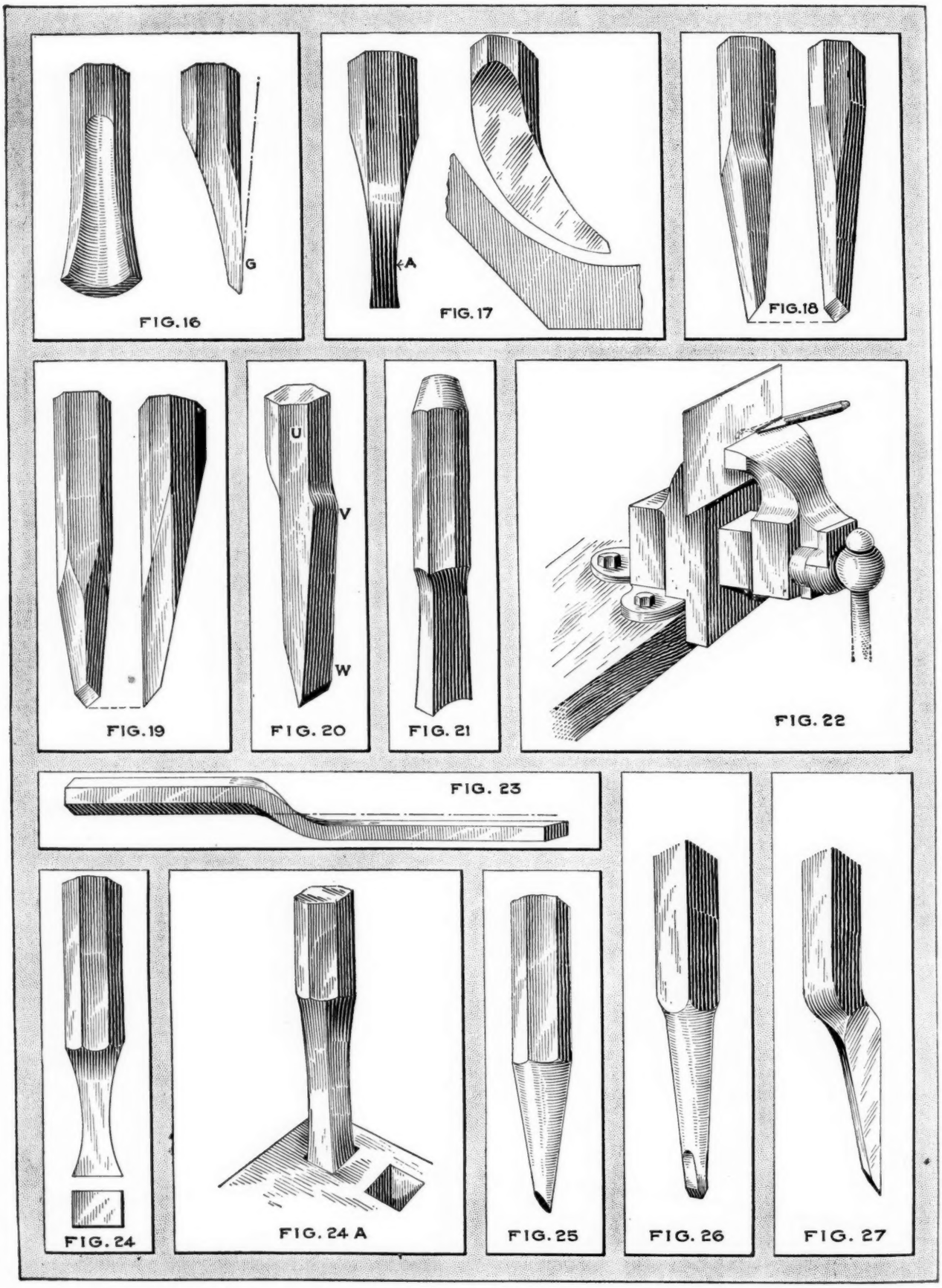
The cutting edge should be slightly rounded in its length. This will strengthen it and also enable a fine finishing chip to be taken, as in Fig. 8, the width of the chip not extending fully across the chisel width. Thus the corners are not under duty and are not, therefore, liable to break or dig in and prevent smooth chipping. In some practice the edge is made straight throughout its length, as shown in Fig. 2. This is permissible in heavy chipping when a cape chisel has been used, but in any event an edge rounded slightly throughout its length is preferable. If the edge is hollowed, as shown in Fig. 10, the chip acts as a wedge to force the corners outward, as denoted by the arrows. This may cause breakage under a heavy cut and, furthermore, a smooth cut cannot be taken when the corners of the chisel meet the work surface.

If the edge facets are ground less on one side than on the other, as in Figs. 9 and 11, edge will not be parallel with the flats of the chisel, so that in holding the tool the flats will not form a guide to determine when the edge lies parallel to the work surface. Fig. 12 shows a wrongly ground chisel that will never cut parallel to the surface of the work. The edge at its center should also be at a right angle to the center line of the chisel, as denoted on the left half of Fig. 12, for if not at a right angle the chisel will be apt to move sideways with each blow and cannot be held steadily.

The chisel should be held as close to its head as possible, so that the hand will steady the point where the blow is received. The tool should be pushed forward firmly and steadily to its cut. This will greatly facilitate rapid and smooth chipping. When working on wrought iron and copper it is found better to occasionally moisten the chisel with oil or turpentine, the former being preferable.



FIGS. 4 TO 15. VARIOUS SHAPES OF CHISELS AND EXAMPLES OF THEIR APPLICATION



FIGS. 16 TO 27. SPECIAL FORMS OF CHISELS AND SOME OF THEIR USES

The heads of all chisels should be dressed round and somewhat reduced in diameter, as shown in Figs. 4 and 5. When the head becomes battered, as in Fig. 5A, it should be redressed, as small pieces of steel are apt to fly from a bushed chisel head, embedding themselves deeply in the hand holding the chisel.

The flat chisel can be modified in form to suit special conditions, as, for example, the cutting of the flat sides of a mortise require a chisel the axis of which will follow a line nearly parallel to the work surface. Such a chisel is shown in Fig. 5, in which one flat is parallel with the length of the chisel, having at the end one wide facet at a slight angle with the length. This is done in order to be able to guide and control the cutting edge of the tool.

All that has been said respecting the flat chisel applies equally well to the cape chisel, except that the sides at right angles to the cutting edge are narrower than the shank and that the sides parallel with the cutting edge are spread wider where they join the shank, as in Fig. 13. The cape chisel will cut up some ugly capers if not properly forged and ground. If not made narrower at *AB* than at *GH* it will, when the corners wear dull or tapering at *GH*, wedge and possibly split a frail piece on which it is being used to cut a slot. Referring to the end view, if the sides *JI* are not ground approximately at right angles with *KL*, the chisel will twist and hang and cannot accurately be guided in a slot or keyway.

When cuts of $\frac{1}{8}$ in. or deeper are to be taken, it is necessary to precede the flat chisel by grooves cut with the aid of a round-nosed chisel. The distance apart of these grooves should be less than the width of the flat chisel, thus leaving strips to be chipped by the latter. This method is used in chipping broad surfaces, but is unnecessary when the area is quite small. The surface shown in Fig. 14 represents this preparatory grooving. Besides the uses already given, the cape chisel is employed for cutting keyways in shafts, pulleys, gears, etc., also for cutting slots.

In cutting a keyway with the cape chisel, if the keyway be made, say, $\frac{5}{8}$ in. wide, the cape should be about $\frac{1}{32}$ in. narrower. The remainder of the keyway is removed by a file. If the keyway be $\frac{3}{4}$ in. or wider, it is better to use a cape chisel less than half the width of the keyway and cut two grooves.

The round-nosed chisel, Fig. 15, may be straight from *H* nearly to the point *G*, but should be beveled near *G* so that the head of the chisel may be raised or lowered to govern the depth of the cut. The round nose should also be wider than the metal higher up, so that the chisel head may be moved sideways to govern the direction of the cut, as is the case with the cape chisel.

The gouge chisel, Fig. 16, should be beveled from *G* to the point, so as to permit governing the depth of the cut. It should have a sharper curvature than the corner it is to cut out, so that its corners cannot wedge in the work. This tool is used for enlarging holes or for chipping curved surfaces.

The oil-groove chisel, Fig. 17, should be wider at the cutting edge than at *A* for reasons similar to those already given, and of less curvature than the bore of the brass of bearing in which it is to cut the oil groove.

The diamond-point chisel may be made in two ways. First, as in Fig. 18, for shallow holes, or as in Fig. 19, for deep ones. In shallow holes the chisel can be swung over, whereas in deep ones it must be held straight so that its body may not meet the other side of the hole, slot or keyway. The form shown in Fig. 18 is the strongest, because its point is brought into line with the body of the steel. The side chisel, Fig. 20, for cutting out the sides of keyways or slots, should be beveled from *W* to the cutting edge for the reasons already given, and straight from *W* to *V*, the line *VW* projecting slightly above or beyond or outside of the body *U*. All these chisels are ordinarily tempered to a blue color.

The ripper, shown in Fig. 21, is for cutting off boiler tubes, tanks, sheet metal, etc. The shape of the cutting blade is on the style of that of the cape chisel. The cutting edge is slightly hollowed to guide the tool in the course of cutting. Sheet metal held in the vise may be much more easily sheared with the ripper than with the ordinary flat chisel. This process is shown in Fig. 22.

The drift, Fig. 24 and 24A, is a tool that is sometimes used instead of a file for enlarging or correcting square, rectangular or polygonal holes. The drift has no cutting edge proper, but the end is at right angles to the body and cuts on the same principle as the punch used in punching holes in boiler plates, or somewhat like the ripper mentioned above.

The key drift is for driving keys out of pulleys, gears, etc. Like the drift, its small end is rectangular in cross-section, but it is not intended to do any cutting, as shown in Fig. 23.

The round-nosed chisel, Fig. 25, and the flat chisel, Fig. 26, are small size and used on light work. The chisel, Fig. 27, is fit for deep, internal work.

In tempering chisels for general use they should be drawn nearly to a blue, which gives a tough temper that will stand up well on all metals except chilled iron and hard steel. For these latter metals, in drawing the temper the chisels should be plunged in water just at the time the color starts to change from straw to blue. In exceptional cases a bright straw color is kept, but in use hammer blows must be comparatively light, otherwise the brittle edge will fail.

No matter how carefully a chisel may be tempered, it may be softened in a few seconds by overheating the edge at the emery wheel. To avoid this a constant flow of water may be directed to the point of the chisel when grinding. If an automatic water supply is not available, the chisel must be frequently dipped in water.

Electric-sign advertisers, says a New York newspaper, while submitting uncomplainingly to the Fuel Administration order regarding lightless nights, nevertheless have always maintained that the greater part of current used for display advertising was overload developed by the lighting and power concerns, for which there was no other use. This is true, but coal is burned to supply the power that furnishes the light with electricity, and coal was what the Fuel Administration wanted to save. It was not a case of saving light, but of saving coal that was needed for more imp rtant purposes than the so-called "White Way" display signs.

Power-plant records are admirable, but they are useless if they are not conscientiously and accurately kept.

Meters and Gages in Boiler Operation

By E. A. UEHLING

THIS ARTICLE INDORSED BY

U. S. FUEL ADMINISTRATION

Combustion is a chemical process and heat absorption is a physical process. To obtain the best results, these processes must be continuously diagnosed and controlled, which may be done by proper instruments.

THERE are on the market many instruments or forms of apparatus designed to facilitate economical steam-boiler operation. All these are more or less useful, some are very desirable, but only a few are absolutely necessary. To be able to discriminate intelligently, the engineer must not only familiarize himself with the construction, operation and specific functions of each class, and take into consideration the value of the information obtainable from each of them separately, but he must also understand the inter-relation of such information and to what extent the information given by one supplements, or is necessary to interpret properly, that given by another.

Aids to Economic Boiler Operation

The means available for aiding the engineer and the fireman in the economic operation of his boilers are of three distinct classes: (1) Mechanical, (2) physical and (3) chemical. In the restricted field of boiler control, all mechanical apparatus give their information in units of actual weight or volume, all physical apparatus give theirs in units of temperature or pressure, and all chemical apparatus give theirs in units of weight or volume of the chemical elements involved, in relation to one another.

The first class of apparatus deals quantitatively with the materials used in, or modified by, the operation of the boiler, regardless of their physical condition or chemical composition; the second class deals with the physical condition of the materials consumed or transformed; and the third class deals with the chemical composition of the materials used and the combustion products formed. Both physical and chemical apparatus give qualitative results; that is, the results are independent of the quantity of the material used or consumed. All apparatus used for continuous control should be equipped with indicating and recording instruments. Coal weighers, water meters or weighers, and steam-flow meters are mechanical apparatus.

By itself the information given by an automatic coal weigher can serve only as a check on the shipping weights of the coal received. It is of no value whatsoever to the engineer, either as a control or as an aid or incentive to improve the operation of his boilers. The fact that the coal weigher tells him how much coal he is using weekly, or even daily, gives him no clue as to whether he is burning his coal wastefully or economically. The installation of a coal weigher would therefore be a waste of money unless supplemented by other apparatus giving information that would make its reading valuable.

The information derived from a water meter is by itself of no greater value than that given by the coal weigher. A knowledge of the weight of water evaporated per day or week gives no indication of the amount of heat wasted in converting it into steam. Inasmuch, however, as the weight of coal consumed can generally be ascertained with some degree of accuracy at intervals, perhaps monthly or at least quarterly, the weight of water evaporated per pound of coal can be calculated and a rough idea of the operation of the boiler can be had, which will lead to efforts in the right direction. If this is done, a water meter may, even without scientific accessories, prove a paying investment.

Value of Information from Steam-Flow Meter

The information obtained from a steam-flow meter placed in the main steam line has the same degree of usefulness as that derived from a water meter. One measures the quantity of water to be evaporated and the other the quantity that has been evaporated. The principal value of steam-flow meters consists in keeping track of the quantity of steam distributed to the several departments of the plant or that used for various purposes in the same department. If each boiler is equipped with a steam-flow meter, the information given is very useful to the operating engineer, because it shows the steaming performance of the individual boilers and so enables him to apply his efforts to improve matters where improvement is most needed. But the boiler that produces the most steam does not necessarily produce it most economically, so that a steam-flow meter on every boiler, though useful and desirable, is of little value as an aid to the engineer in his endeavors to find out causes and in applying remedies to improve his practice.

Coal Weigher Should Be Used With Water Meter

It was shown that a coal weigher by itself is of practically no value and that a water meter has a chance for usefulness, because the coal consumed can be approximately ascertained at monthly or quarterly intervals. The two together, however, will give the data necessary to calculate roughly the efficiency of the boilers. This knowledge is of the greatest value to the manager, serving him as a club to swing over the engineer, to hold him to the standard that may have been set, whether arbitrarily or by efficiency test. It is a wholesale exposure of the performance of all the boilers, but it gives the engineer no clue whatever as to the exact cause of failure or success. Failure may be due to the quality of the coal, to bad firing, dirty boilers, broken-down baffling or unobserved cracks in the boiler settings. He can improve matters only by cut-and-try methods, by which maximum efficiency may be spasmodically attained but cannot be regularly maintained.

The physical instruments necessary or desirable and more or less usefully employed in the daily operation of boilers are: The steam gage, the thermometer, the

pyrometer, the draft gage and the barometer. There are also various combinations of physical instruments for which much controlling virtue is claimed. Their claims must be carefully and critically scrutinized by the engineer.

The steam gage is a necessity for every boiler, since not even an approximately uniform steam pressure could be held by the most expert and conscientious fireman without it. The greatest value of the indicating steam gage is that it shows the fireman when, how often and how hard to fire. The recording steam gage is of great value to the engineer, because its record tells him how faithfully his firemen attend to their duties, so far as effective firing is concerned; but it gives no information as to whether the firing is done economically or wastefully. The steam gage is therefore an operating necessity, but has no economic utility.

Value of Thermometer in Boiler Room

The thermometer gives information valuable by itself as well as in conjunction with that given by other instruments. It is very essential that the engineer should keep close watch on the temperature of the feed water and also on the temperature of the steam, especially where superheaters are employed. Feed-water temperature and superheat are important factors in power-plant economy. The one decreases the work that must be done by the boiler, and the other increases the work that can be done by the engine with the steam generated. It also is important to know the temperature of the air used for combustion. This is of no value by itself, but it is an essential factor in calculating the heat wasted up the chimney. Recording thermometers should be installed wherever the size of the plant warrants the outlay.

Pyrometers are essential to the economic operation of boilers, but they must be properly installed and the information they give must be considered with that of other instruments. The information derived from a pyrometer in the main gas flue or chimney is of practically no value. A pyrometer showing the temperature of the furnace would be of great value; but since it is difficult to find a pyrometer that can stand up continuously under the high temperatures prevailing in a properly constructed boiler furnace, it is useless to discuss the value of a knowledge of the correct furnace temperature here. Fortunately, the guidance to combustion efficiency which such knowledge would give can be obtained in more useful form by other means.

Proper Location of Pyrometer

The proper place for the pyrometer is in the uptake of every boiler, where its function is to act as a telltale on the absorption efficiency. But the temperature of the escaping gases may be affected by many disturbing factors, such as air infiltration, rate of driving, broken-down baffling, etc., so that the information given by a pyrometer in the uptake is by itself no reliable index to the absorption efficiency of a boiler. Yet although a knowledge of the temperature of the escaping gases is by itself of little value, and may even be misleading, it is of the greatest value in conjunction with that derived from a CO_2 meter and differential draft gage. All pyrometers should be of the autographic recording type.

The draft gage is a most important accessory to a steam boiler; but a draft gage in the chimney is of no value whatsoever in operating a battery of boilers, since it does not tell what draft each boiler gets or needs for proper combustion. The chimney draft must be in excess of that required by the boilers, and if it is not it must be supplemented by mechanical draft. Draft must be regulated to meet the combustion requirements. The chimney draft cannot be changed at will. Draft control by a damper in the chimney or main gas flue serving a number of boilers is unscientific and not conducive to economical operation. The automatic control of such a damper may be useful in maintaining an even steam pressure, but it is not conducive to the best results. The most efficient draft is never the same for all the boilers in a battery. To get maximum combustion efficiency, the draft of every boiler must be individually regulated. A simple draft gage in the uptake before the damper of every boiler gives more useful information, inasmuch as it indicates the effective draft on every boiler, and each is responsive to its damper regulation; but since it does not differentiate between the resistance through the fire (furnace draft) and that through the boiler (boiler draft), it does not give the fireman all the information necessary for intelligent regulation of combustion.

Factors Affecting Draft Intensity

Effective draft is the drop in pressure between the ashpit and the damper, or the sum of the furnace draft and the boiler draft, and it necessarily varies as its two components vary. With the same rate of combustion per square foot of grate surface, the furnace draft varies with the construction of the grate, the kind and physical condition of the coal, the method of stoking, the condition and thickness of the fire and ash bed, and the percentage of excess air used. The boiler draft varies with the type of boiler, the arrangement of the baffling, the condition of the baffling, the rate of driving and the percentage of excess air. From this it is evident that since so many variable conditions are involved, the same strength of effective draft cannot always produce the same rate of combustion; therefore, it is neither scientifically correct nor practically feasible to set narrow limits to the effective draft. If the draft necessarily varies with a constant load, it must vary still more with a variable load on the boilers. There is no fixed relation between boiler draft and furnace draft, and instruments with fixed indexes purporting to show such relation may be quite misleading.

An examination of the half-dozen or more variables that influence draft will show that only two of them, namely, the percentage of excess air and the rate of combustion, can affect the two draft components similarly and at the same time. Consequently, for intelligent draft regulation these two components must be separately observed. If the percentage of excess air is kept within proper limits, the boiler draft is a reliable index to the rate of combustion. A sudden drop in the boiler draft indicates broken-down or damaged baffling, which will be immediately corroborated by the pyrometer in the uptake, showing a corresponding rise in the temperature of the escaping gases.

For these reasons the fireman should have continuously before him the boiler draft and also the furnace

draft, or at least the means of readily ascertaining the latter. He must, therefore, be provided with a double differential draft gage or a draft analyzer. It is evident, from the variable nature of the conditions on which the draft depends, that it cannot be regulated to any fixed index on the draft gage. More or less ingenious combinations of differential draft gages and steam-flow meters have been devised for the purpose of controlling combustion, but all such are of doubtful utility excepting under conditions assuring very narrow limits of variation in the operating requirements.

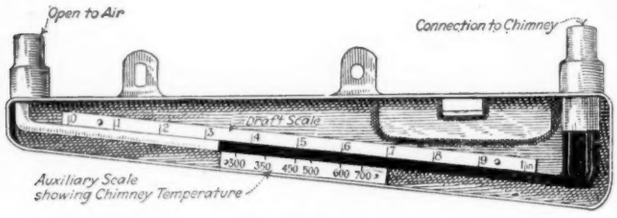
The barometer is not essential to the intelligent operation of boilers, but it is essential to the correction of the readings of the ordinary vacuum gage and should be included as part of the equipment of the engine room, preferably in combination with a recording vacuum gage, as it enables the correct vacuum to be read off at a glance. A barometer is of considerable interest to the boiler-room force, however, inasmuch as the chimney draft is materially affected by the atmospheric pressure.

Finding Chimney Temperature by Use of Draft Gage

By James M. Purcell

OPERATORS of steam plants should by this time appreciate the necessity for fuel conservation. If they do not, they may discover it on the return of their questionnaires with ratings so low that they may have difficulty in obtaining coal.

At the base of all efforts toward efficiency in plant operation are instruments and records. Instruments are necessary to indicate the results being obtained, and



ARRANGING DRAFT GAGE TO SHOW CHIMNEY TEMPERATURE

records are required in order to make comparisons with past performances.

There are some instruments that are not absolutely necessary, but of decided advantage, and there are others that cannot be dispensed with under any circumstances. If an important instrument can be made to serve two useful purposes, a step toward conservation has been taken.

No boiler room should be without a draft gage, for it can be obtained at a price well within the reach of the smallest plant. Such a gage may be used to indicate not only the chimney draft but also the approximate temperature of the chimney gases, and the temperature of these gases is a direct measure of the heat lost up the chimney, since every pound of flue gases carries off 0.24 B.t.u. for each degree of temperature above that of the steam in the boiler. This loss cannot be wholly avoided, but a reduction of chimney-gas temperature is an indication of partial elimination.

Draft is commonly defined as the difference of pressure between the weight of the column of gases inside the chimney and the weight of a corresponding column of outside air, this difference usually being expressed in inches of water. The amount or strength of the draft depends on the temperature of the gases inside the chimney, the temperature of the outside air and the height of the chimney. The relations of these factors are given by the formula,

$$D = 7.64 \left(\frac{1}{T} - \frac{1}{T'}\right) \times H$$

in which

D = Draft at base of chimney, in inches of water;
T = Absolute temperature of outside air, in degrees F.;
T' = Absolute temperature of chimney gases, in degrees F.;
H = Height of chimney, in feet.

The foregoing formula may be written in the simple form $D = KH$, where $K = 7.64 \left(\frac{1}{T} - \frac{1}{T'}\right)$. Under average conditions the temperature of the outside air is 60 deg. F., or $T = 460 + 60 = 520$ deg., absolute. Assuming chimney temperatures of from 350 to 750 deg. F., advancing by 50 deg., and substituting in the formula for K, the following values are obtained:

Chimney Temperature, Deg. F.	Value of K	Chimney Temperature, Deg. F.	Value of K	Chimney Temperature, Deg. F.	Value of K
350	0.0053	500	0.0067	650	0.0078
400	0.0058	550	0.0071	700	0.0081
450	0.0063	600	0.0075	750	0.0084

Having a table of this kind, it is possible to determine the chimney temperature by reading the draft gage. By one of the preceding formulas $D = KH$, which is true only under theoretically perfect conditions. If friction is taken into account, the draft will be less. Suppose that the friction loss is 0.2 or 20 per cent. and let D' represent the actual draft. Then, $D' = 0.8KH$, from which $K = \frac{D'}{0.8H}$. Having this formula, take the reading of the draft gage and substitute that value for D', and for H substitute the height of the chimney and find K. Then refer to the table, and the temperature corresponding to the value of K will be the approximate chimney temperature.

To illustrate, suppose that the draft at the base of a 100-ft. chimney is 0.6 in. and that the temperature of the gases in the chimney is to be found. Substituting $H = 100$ and $D' = 0.6$ in the last formula, $K = \frac{0.6}{0.8 \times 100} = 0.0075$. In the table the value of 0.0075 for K corresponds to 600 deg. Therefore, the temperature of the chimney gases is 600 deg. F., approximately.

It is not necessary to make this calculation each time a reading is taken on the draft gage. Instead, the calculations may be made for the several readings of the gage and the corresponding temperatures may thus be found. These can then be marked on a strip of paper so as to form an auxiliary scale on the gage, as shown in the illustration. Then, opposite the gage reading would be found the temperature, without any calculation. Of course the auxiliary scale would be different for different heights of chimney. The foregoing formulas, however, may be used to obtain a scale for any given set of conditions.

New Jones Automatic Stoker

A new automatic cleaning underfeed stoker has been developed by the Under-Feed Stoker Co. of America. It is similar to the standard Jones underfeed stoker, but in addition has been made self-cleaning. For over two years this new type, shown in Fig. 1, has been in use in plants burning different grades of coal under widely varying load conditions.

Coal is fed into the hoppers in front, either by gravity from storage above or by hand. The steam cylinder below and in front of the hopper operates a ram and pusher-rod. As this steam-operated ram moves in toward the fire, it pushes a charge of fresh coal from the hopper into the retort, or coal magazine, which supports the fuel bed. As this coal is pushed into the retort, it moves the previous charge of coal slightly backward and upward. This intermittent, slow and easy process keeps fresh coal fed into the fuel bed from below. As this coal is gradually forced upward, the heat from the incandescent zone above drives the volatile gases from the fresh coal before the actual burning takes place. These gases mix with the air admitted through the tuyeres, and the mixture passes upward through the hot fuel above. The gasless coal or coke, which is left, is forced to the upper part of the fuel bed (the incandescent zone) by the new fuel coming in, where it burns with the gas coming up from below. This process gives a clean, hot coke and gas fire.

As the coke burns, the intermittent movement of the fuel, caused by the feeding of the fresh coal from below, moves the burning fuel bed with ash and refuse slowly toward the rear. This is not a gravity movement, as the slope of the retorts is not sufficient to cause the ash and refuse to slide or roll toward the dump plate. The movement is primarily caused by the intermittent upward and backward motion of the fuel resulting from the action of the steam ram. This backward movement, assisted by the pusher-rod and blocks, carries the fuel bed slowly toward the rear, so that when it reaches the dump plate, the coal is entirely burned and there is nothing left but dead ash. This method tends to keep the fire clean of ash and refuse and to prevent "avalanching" of the burning fuel onto the dump plate.

As the refuse accumulates on the balanced dump plate at the rear of the furnace, the plate is dropped, dumping the ashes into the pit below, as shown in Fig. 2. This is done at infrequent intervals and is the only manual operation necessary, as the cleaning is automatic, a feature effecting an important saving in labor.

In any stoker the highest fuel economy is obtained only when just enough air is supplied to completely burn the coal. Too much air cools the steam-making surface and necessitates the burning of more coal; too little air does not permit perfect combustion, with the result that all the available heat of the fuel is not utilized. A low percentage of CO_2 in the flue gases is an indication of too much air; a high percentage of CO means too little air. The correct amount of air per pound of coal depends upon the coal, the atmospheric conditions and other factors. It will be understood that independent adjustments of the fuel and air controls are necessary to obtain the best fuel economy. Incorporation of this feature in the Jones system, together with the fact that the fire is not cleaned by hand through open doors and that the fuel is burned before it reaches the rear dump plates, tends to insure high economy and practically smokeless operation.

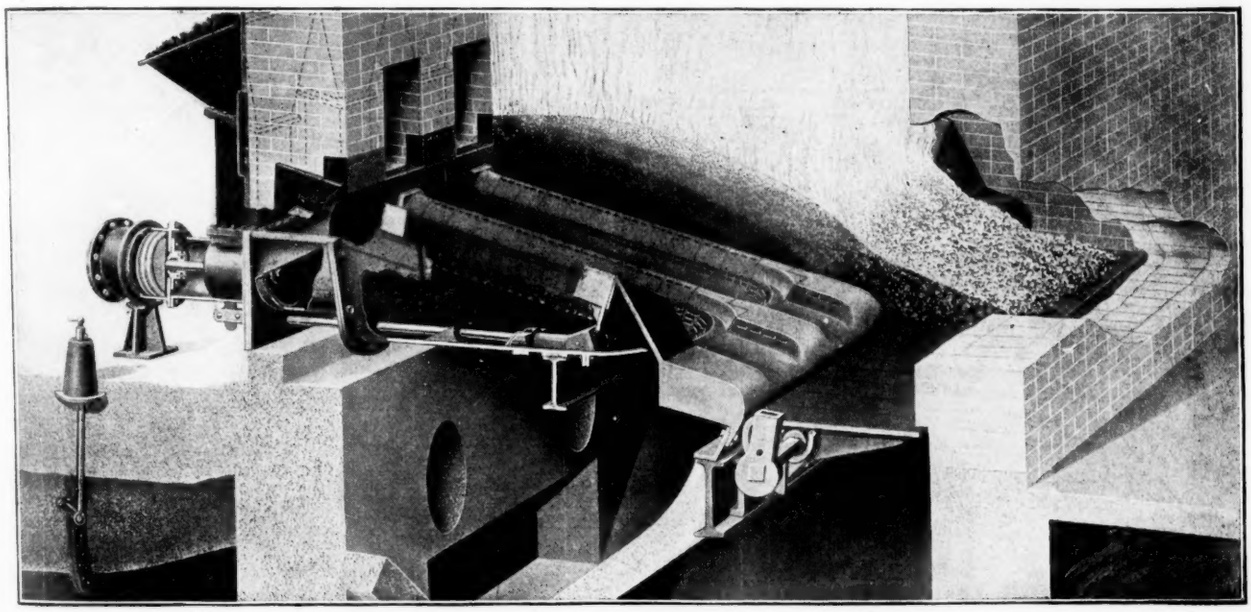


FIG. 1. THE NEW JONES AUTOMATIC, SELF-CLEANING UNDERFEED STOKER

The air supply is automatically controlled by the steam pressure, and the coal supply is under the same control, but is subject to independent regulation. A drop in steam pressure brings increased fuel and air, which builds up the pressure. An increase in pressure lessens the fuel and the air supply until the pressure is reduced. That the system is responsive to sudden changes in load and will maintain uniform pressure is indicated in Fig. 3, a flow-meter chart, and Fig. 4, a pressure chart, both taken over the same period of time in a plant under normal operating conditions.

Each retort in a battery is operated independently of the others. This feature, in conjunction with the wide range of control over the coal and air supply, gives unusual flexibility. With the tuyere openings arranged to supply plenty of air, the stoker also has large coal-burning capacity per square foot of furnace area, making it suitable for plants where there is a wide variation in load or where heavy overloads must be carried.

Observation doors are built in the front of the setting opposite each row of tuyeres. These doors enable

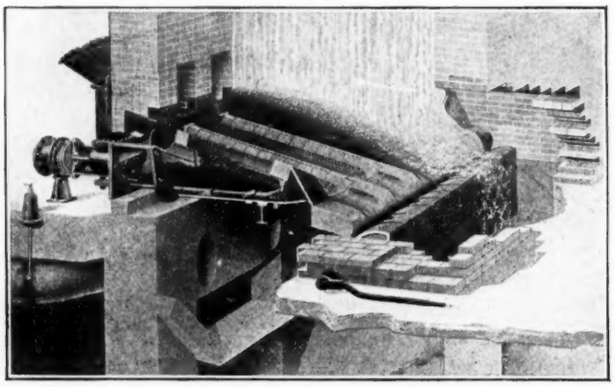


FIG. 2. THE DUMP-PLATE DROPPED DOWN

the firemen to watch the fire and keep it in good condition. The operator can work through the doors and down each row of tuyeres with a slice bar should any clinker form on the tuyere blocks. If a hole is found in the fire, it can be filled by feeding more coal to that retort. As each steam cylinder can be operated independently of the others, the coal supply to each section

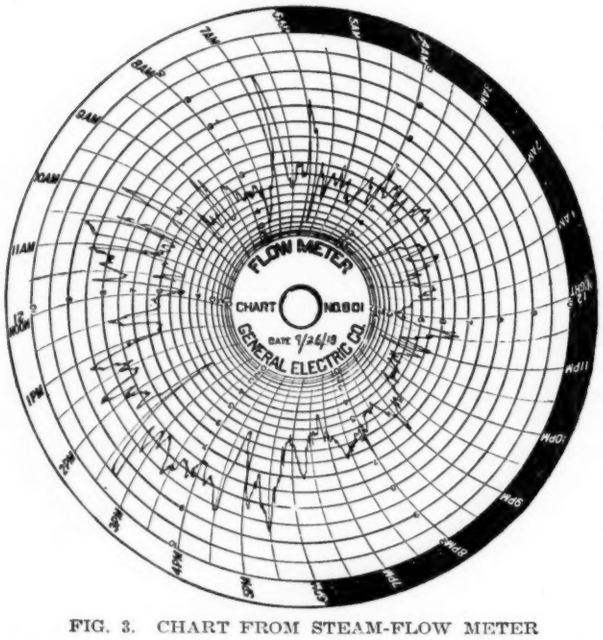


FIG. 3. CHART FROM STEAM-FLOW METER

of the fire is subject to individual control, so that an even fuel bed can be maintained. That the intermittent breaking up of the fuel bed as fresh coal is supplied prevents the formation of large clinkers is indicated by the results of sieve tests showing that approximately 75 per cent. of the total ash goes through a 2-in. mesh, and 85 per cent. through an 8-in. mesh.

The action of the steam ram is not positive. Foreign substances that may get into the hopper will stop it, but as soon as they are removed the ram operates again, nothing is broken and the stoker need not be stopped, although if necessary any retort in a battery can be shut down, as each one is operated independently of the others. The only moving parts within the furnace are

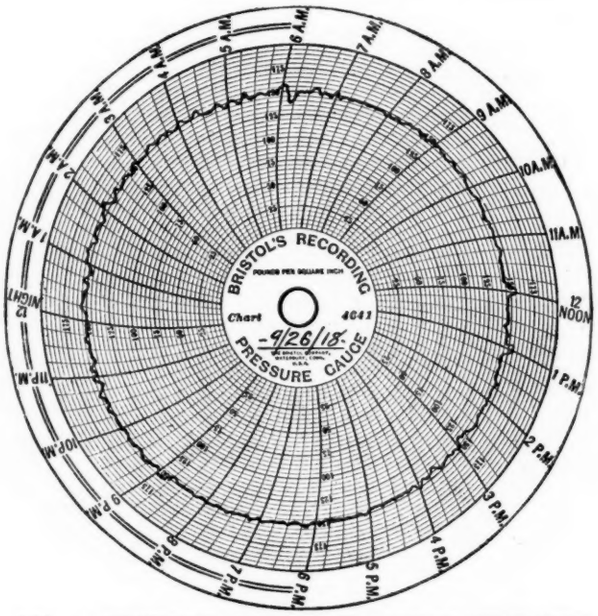


FIG. 4. PRESSURE CHART FROM BOILER WITH NEW JONES STOKER

the pusher-rods and blocks, and these are below the incandescent zone. The tuyere blocks will burn out, but it is easy to replace them as each block is held in the retort by a rod which can be removed from the front of the furnace, so that the new tuyere block can be slipped in place without seriously disturbing the fire.

Reinforced Concrete Saves Steel in Power Plant

IF THE steel shortage should become more acute, power-plant designers themselves probably would be surprised to find how far they could go in substituting other materials for steel. A pioneer example is the 15,000-kw. Buffington, Ind., plant of the Universal Portland Cement Co. In the design an attempt was made to utilize reinforced concrete as far as possible. The station as built is 106 ft. 8 in. by 72 ft. 3 in. in plan and is constructed entirely of reinforced concrete with concrete-block curtain walls and hollow concrete roof-tile covering. It is separated into two parts by a concrete-block division wall. The generating end contains two 7500-kw. turbo-generator units and the exciters, condensers, piping, etc. The transforming and switching end contains equipment required for distributing the energy to the various substations.

Foundations are of the mass concrete type built on a sand bearing surface, concrete piles being used wherever necessary to take care of the heavy loading coming on them. No unusual features were encountered in their design. The framework of the building is of the self-contained skeleton type, such as is being used in recent warehouse-building construction and carries the concrete-block curtain walls.

In the calculations for the design of this building the stresses assumed were as follows: Steel in tension, 18,000 lb. per sq.in.; concrete in compression, 700 lb. per sq.in.; concrete in direct compression, 550 lb. per sq.in.; concrete in shear, 40 lb. per sq.in. The main generating, or turbine, floor was designed to carry a superimposed load of 500 lb. per sq.ft., and while this is slightly under the load caused by the heaviest machine part likely to be placed on it, it was deemed sufficient to take care of all ordinary circumstances. The floor varies in thickness from 6 to 11½ in. and is reinforced with ½-in. diameter rods.

Traveling Cranes Supported on Reinforced Concrete Columns

The design of the columns presented no unusual features. They are square and rectangular in shape. Those in the center of the transforming end supporting the second floor measure 24 x 24 in. and those supporting the third floor measure 21 x 21 in. Those supporting the roof girders are 18 x 18 in. The remainder of the columns in the building are rectangular in shape and measure 27 x 33 in. All columns are reinforced with round rods of different sizes and numbers according to the strength required to take care of the loads they carry. The columns that carry the crane runway girders are reduced in section above the girders to 15x33 in. and these in turn carry the roof girders. Especial care was taken to see that any tendency to bending in these narrow columns due to wind racking was properly provided for.

Crane runway girders designed to carry a 30-ton traveling crane are 18 ft. span, 41 in. deep and 18 in. wide, reinforced with four 1⅝-in. diameter rods in the top and bottom and the necessary rods in the web to take care of the shear. The roof joists were designed to carry a total roof load of 60 lb. per sq.ft. on an 18-ft. span. They are 18 in. deep by 7 in. wide and are reinforced with one 1½-in. diameter rod in the bottom and two ¾-in. diameter rods in the top. These roof joists were premolded on the ground and hoisted into place when the forms for the roof girders were constructed, the reinforcing rods being arranged in such a manner as to insure a thorough bond and joint with the main girders when they were cast so that there would be no tendency to pull out of the main girder when the load was applied. This method of roof construction has been followed for some years by this company with good results, as it eliminates the necessity of building forms and supports up in the air for these joists.

Reinforced Concrete Girders 63 Ft. Long

Owing to the length of the span, 63 ft., the main roof girders supporting the roof joists present some unusual features. The girder is 18 in. wide and 71 in. deep at the center. The top surface slopes with the roof ½ in. in 12 in., the bottom surface being horizontal for a distance of 41 ft. from which point it tapers down to a depth of 66 in. at the connection of the girder to the columns. The girder is reinforced with eight 1⅝-in. diameter rods in the bottom and eight 1½-in. diameter rods in the top. The shear rods in the web are ⅜ in. diameter and in the form of vertical stirrups. The majority of the girders in this building were designed with compression reinforcement with the idea of keeping down the depth and width of the girders to the minimum and to keep the appearance consistent with the design in its entirety.

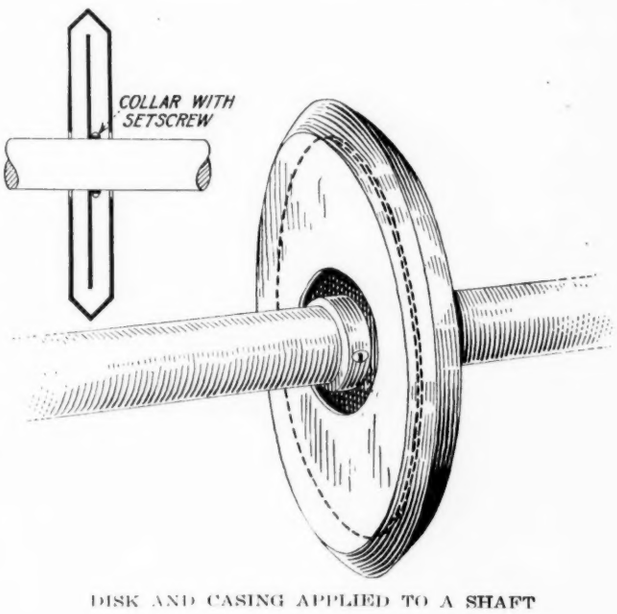
The roof is composed of hollow reinforced-concrete slabs, shipped to the job and laid on the roof joists. On top of the slabs was laid a composition tar and asbestos cement covering to make the roof waterproof.

All the concrete in the building above the foundations was mixed in the proportions of 1 of cement, 2 of sand and 4 of pebbles passing a 1-in. ring, with the exception of the concrete in the columns carrying the crane and large roof girders, which was mixed 1 of cement, 1½ of sand and 3 of pebbles. This difference was made to take advantage of the extra strength of the richer mixture.

In the transformer end of the building the floors were designed for a load of 150 lb. per sq.ft. and are of the usual girder and slab construction, presenting no unusual features. All the switch cells, busbar structures and supports were made entirely of concrete either cast or plastered on expanded metal, which gives fireproof structure throughout. The building presents a neat, substantial and pleasing appearance and is satisfactory to the company in every way.

Anti-Oil-Throwing Disk

A short line of shafting caused considerable inconvenience and loss of oil, because the lubricant would leak out of the bearing boxes and travel along the shaft until it encountered a pulley, where it would come



DISK AND CASING APPLIED TO A SHAFT

in contact with the belt or be thrown on the floor, wall and ceiling. The device illustrated was designed to remedy this. A disk of galvanized tin, 18 in. in diameter was mounted on the shaft close to the bearings. The oil traveled along the shaft until it reached the disk, when it was carried toward the edge and was then thrown by centrifugal force into a casing surrounding the disk. From this casing the oil was drained into an oil can and again made ready for use.

The Electrical Study Course—Faults in Generators and Motors—IV

Presents a detailed description of methods employed to determine the part of an armature or field winding that is grounded. Also contains suggestions regarding the identification of dismantled machines whose history is not known and the manner of their rehabilitation.

IN THE previous lesson means for determining the existence of grounds in armature and field windings were discussed, and we shall now see how it is possible to isolate the part in which the trouble exists. We shall first deal with tests for armatures and subsequently with those for field coils.

Assume that a ground exists in the coil connected

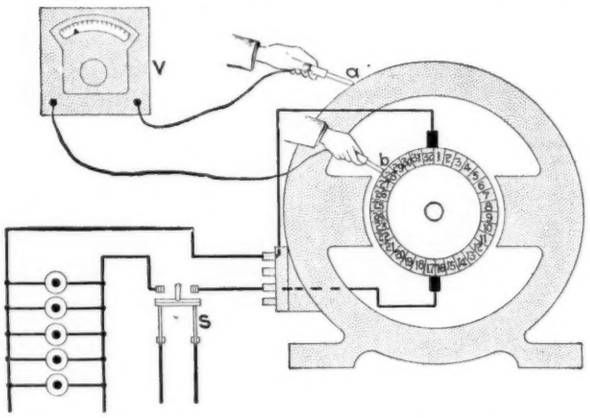


FIG. 1. METHOD OF TESTING FOR GROUNDED COIL IN ARMATURE OF MOTOR OR GENERATOR

between segments 5 and 6 of the armature illustrated in Fig. 1, which shows the connections required to make such a test by means of a low-reading voltmeter *V*. The brushes of the machine are connected in series with a bank of lamps or other form of resistance to a source of voltage such as switch *S*, the current being adjusted not to exceed full-load value. One terminal of the voltmeter *V* is then held permanently to some part of the frame of the machine, as at *a*, care should be taken that contact is actually made with the metal of the frame; the filler and paint used on many machines cover the frame with an insulating coating that prevents contact with the metal it covers, and the terminal *a* should therefore be held against a part of the frame that is free of such coating. The other voltmeter lead *b* is then touched to each of the commutator segments beginning with one at the brushes, as No. 1 or 32, or 16 or 17.

At any of these brushes some reading of the voltmeter will be obtained, that for 1 and 32 being the same; likewise that for 16 and 17. As contact is made with successive segments, as 2, 3, etc., or 31, 30, etc., the reading will gradually become smaller and smaller until, when segment 5 or 6 is reached, the reading will become zero or very nearly so. The reason for this will be understood by referring to Fig. 2, which represents the same machine as that illustrated in Fig. 1. The ground is represented as existing at *a*, and since the armature core *c* is in electrical contact with the frame *d* through the shaft and bearings, we may indicate a connection between the coil at *a* and the frame, as is done by the broken line *b*. This representation may be further simplified by a diagram such as that in Fig. 3, in which the armature winding is shown as a resistance *R*, the commutator segments by the terminals 1, 2, 3, etc., and the frame by the line *F*. It will be seen from this that connecting one terminal of the voltmeter to the frame is equivalent to connecting it to the point of ground, namely, *a*, through the path *b*.

Leaving this diagram for a moment, let us give consideration to that of Fig. 5, in which is represented part of the resistance *R* of the armature developed along a straight path. Since current flows through *R* from *e* to *f*, there will be a certain drop of voltage across it, equal to *IR*, where *I* is the current in amperes and *R* the resistance in ohms. Suppose, for example, that $R = 0.2$ ohm and that $I = 30$ amperes; then the voltage drop *IR* is $30 \times 0.2 = 6$ volts. Since there are 15 coils between *e* and *f*, the drop in voltage across each would be $\frac{1}{15} \times 6 = 0.4$ volt. The ground *a* is midway between 5 and 6 and therefore $4\frac{1}{2}$ coils from *e* and $10\frac{1}{2}$ from *f*, and the drop of voltage between it and those points will consequently be $4.5 \times 0.4 = 1.8$ volts and $10.5 \times 0.4 = 4.2$ volts respectively. A voltmeter connected between *a* and *e* or between *a* and *f* would indicate those values. Also, if the voltmeter were connected between *a* and 5 or *a* and 6, it would record a voltage of $\frac{1}{2} \times 0.4 = 0.2$ volt; if between *a* and 4 or 7 a voltage of $1\frac{1}{2} \times 0.4 = 0.6$ volt, and so on, the voltage for each succeeding segment being 0.4 volt higher than

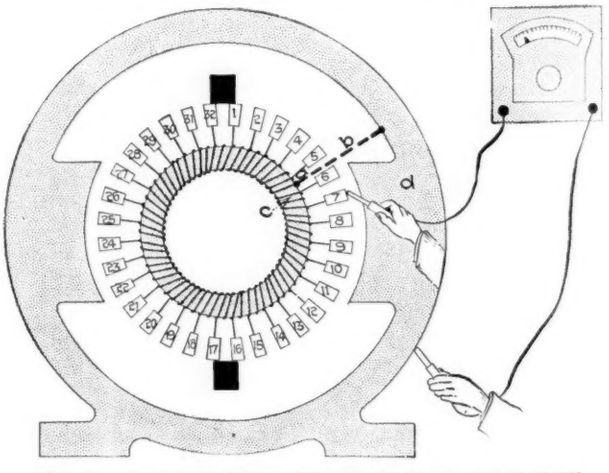


FIG. 2. ILLUSTRATING DIAGRAMMATICALLY HOW GROUNDED COIL MAKES CONTACT WITH FRAME OF MACHINE

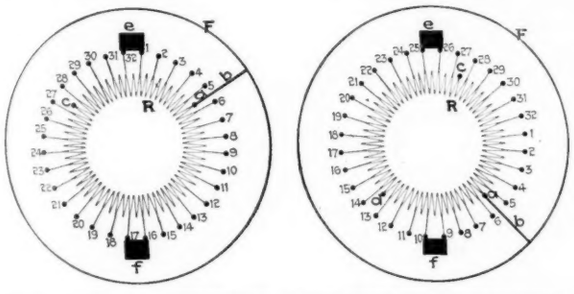
the preceding one until the maximum of 1.8 volts is reached in one direction and 4.2 volts in the other.

Now going back to Fig. 3 again, it is apparent that connecting the voltmeter between the frame *F* and the segments 1, 2, 3, etc., is the same thing as connecting

it between *a* and those points. Consequently, by making connection between the frame and the various segments, we will get the results just obtained in the study of Fig. 5, in which it was shown that the minimum voltage is recorded by the voltmeter when contact is made to 5 or 6, and that the reading increases the further we get away from those segments. Minimum reading of the voltmeter therefore locates the coil in which the ground exists.

Further investigation of the test shows that it is possible to form erroneous conclusions from it unless some method of checking the results is used. The possible error is due to the following reasons: There are two paths for the current through the armature from *e* to *f* (since the machine under consideration is a two-pole one), one path being from 1 to 16 and the other from 32 to 17. The latter circuit is identical with the former, and the same drop in voltage will exist between 32 and 31 as exists between 1 and 2; so also that between 32 and 30 will equal that between 1 and 3, and so on. That is, for every drop across the one path there will be a corresponding drop in the other. Consequently, upon making a test with a voltmeter the voltage from *F* to 31 will be found to be the same as that from *F* to 2 and that from *F* to 30 the same as from *F* to 3, and so on around both halves of the commutator. It will therefore be found that the voltage between *F* and 5 or 6 will also be recorded between *F* and 28 or 27, which would make it appear that a ground existed at the point *c*, although such is not the case. An apparent ground of this kind which has no existence is often referred to as a phantom ground. It can readily be distinguished from the true ground by moving the armature through a few degrees and repeating the test.

Suppose the armature of Fig. 3 to be turned in a clockwise direction until it occupies the position represented in Fig. 4. When the voltmeter is connected



FIGS. 3 AND 4. SHOWING HOW THE TRUE GROUND REMAINS ALWAYS BETWEEN THE SAME SEGMENTS, WHEREAS THE PHANTOM GROUND SHIFTS ON COMMUTATOR

from *F* to 5 or 6, it will register about 0.2 volt as before; so also if it is connected from *F* to 13 or 14, indicating that the ground may be either at *a* or at *d*. The segments 27 and 28, between which is the point *c*, which on the first test gave the same voltage readings as *a*, would now give readings of $9\frac{1}{2} \times 0.4 = 3.8$ volts at 28 and $10\frac{1}{2} \times 0.4 = 4.2$ volts at 27, since they are removed $9\frac{1}{2}$ and $10\frac{1}{2}$ coils, respectively, from *a*. So for every position of the armature the voltage between the frame and segment 5 or 6 will always be 0.2 volt, and there will always be two segments on the opposite side of the commutator which will give that reading, but these latter will be different for each position of the armature. Consequently, the identification of the true ground is a simple matter; it is located between segments 5 and 6. That is, the segments that always indicate zero or nearly zero voltage irrespective of their position in reference to the brushes are the ones between which the grounded coil is situated, whereas those that indicate zero voltage in one position but a greater voltage in another are not connected to a ground at all.

To determine in which coil of a field circuit a ground exists, we proceed in much the same manner as in the case of the armature except that a high-reading volt-

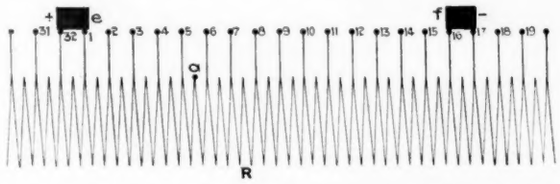


FIG. 5. SIMPLIFIED DIAGRAM TO ILLUSTRATE DROP IN VOLTAGE FROM GROUND TO COMMUTATOR SEGMENTS

meter must be used when testing shunt fields. The machine may be running in actual service while the test is made if so desired. In any event normal current is passed through it and then one lead of the voltmeter is held to the frame while the other is touched to the connection points *a*, *b*, *c*, etc., as in Fig. 6. The ground is situated in the coil whose terminals show the lowest voltage, in exactly the same way as the grounded coil of an armature is indicated by the low voltage recorded when contact is made with the commutator segments to which it is connected. If the test is to be performed on a series machine or on the series field of a compound one, a low-reading voltmeter should be used as for the armature test, and sufficient load must be placed upon the machine to cause a current of some magnitude, such as half normal for example, to flow; otherwise the voltage drop across the windings will be very small and satisfactory voltmeter deflections cannot be obtained. If a series field is to be tested while the machine is at standstill, it will of course be necessary to put a current-limiting resistance, such as a bank of lamps, in series with the field coils when connecting them to a source of voltage, just as in the case of testing an armature.

The only cure for a grounded coil is to remove it and reinsulate the winding at the point of breakdown. As already stated, no direct harm can result from running a machine in which a ground exists provided neither of the terminals has been grounded purposely, but serious damage may result if a second ground should develop before the first one is removed.

Before leaving the topic of tests on machines, we shall give some consideration to that phase of the subject which relates to the rehabilitation of old and partly dismantled motors. Oftentimes the nameplates have been removed, so that it is not even known of what type the machine is, or all the field connections may have been broken, or other like complications may present themselves. A few tests will therefore be described which can be used to advantage in restoring such machines to useful service.

If it is not known whether the motor is a shunt or

series one, the size of the wire in the field coils can be used as a guide in determining to which class it belongs. A surer test it to measure the resistance of the field circuit and of the armature circuit and compare the two. If the field resistance is of about the same value as that of the armature, the motor is of the series type; if it is very much higher, it is of the shunt type. The resistance can readily be determined

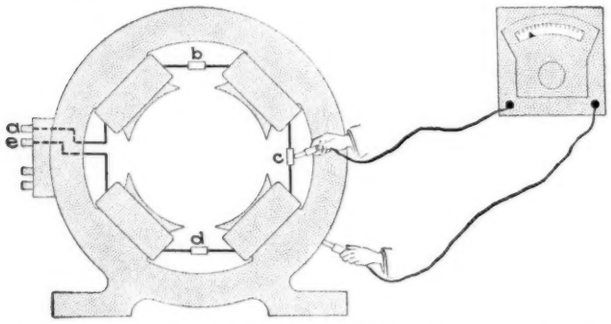


FIG. 6. METHOD OF TESTING FOR GROUNDED FIELD COIL OF A MOTOR OR GENERATOR

by passing current through the windings and measuring it and the voltage across the terminals. For this purpose a bank of lamps or other suitable resistance should be connected in series with the windings to limit the current to a safe value if the field should happen to be a series one. If R represents the resistance in ohms of the field windings, I the current in amperes flowing through them, and E the voltage in volts across them while current I is flowing, then the resistance is of course found from the expression $R = \frac{E}{I}$. Some old types of series motors may be found to have series fields of quite a high resistance, and they may consequently be erroneously classed as shunt machines. If connected as such they will be found to run at a speed much below normal and the field coils will become excessively hot. There can be little doubt whether or not a motor is of the compound type, since the fact would be revealed by the presence of two windings in each coil. If doubt exists as to which is the shunt and which the series, they may be connected in series to normal voltage and the voltage drop across each measured. The one across which the higher voltage exists is the shunt winding.

When the voltage of the machine is not known, it is a matter of some difficulty to discover what its normal value is. If of the shunt type one method is to pass currents of increasing value through the coils, allowing the temperature time to become stationary at one value of current before proceeding to the next higher. The current which causes a rise in temperature of about 40 deg. C. (72 deg. F.) may be considered to be normal, and the voltage required across the windings to make this current flow would then be the normal voltage. In that manner it can be determined whether the machine was built to operate on voltages around 115 volts, 230 volts, 500 volts, etc.

The temperature may be obtained by means of a thermometer inserted as close to one of the windings as possible and covered with cotton waste to prevent air drafts from cooling it. If the machine is of the series type, a similar temperature test can be made, but in this case the currents required will of course be much larger for the same size of machine. The normal voltage must, however, be determined by a different method. From current and voltage readings taken for the purpose the resistance of the armature should be computed. It may be assumed that at full load the voltage drop due to armature resistance is about 10 per cent. of the applied voltage. Thus, if R represents the ohms resistance of the armature and I the amperes found to give normal heating, then the armature resistance drop is IR, and if E is supposed to be the normal voltage, we have $E = 10IR$ volts. It should, however, be borne in mind that the result is a mere approximation which may vary considerably for different designs of machines. If the machine is a compound one, its normal voltage may be determined by the same method as was employed for the shunt type.

If the field coils are found to be disconnected, the correct reconnections can be determined by the use of a small compass needle or by means of a simple bar magnet to the center of which a piece of thread has been tied. Alternate polepieces should, of course, be of opposite polarities when current is passed through the

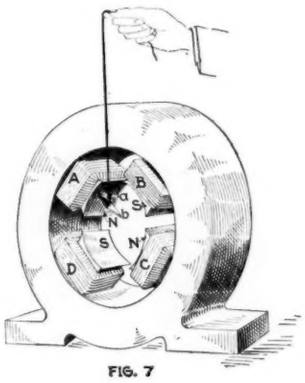


FIG. 7

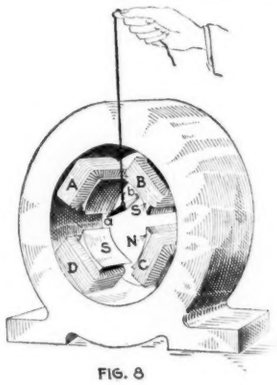


FIG. 8

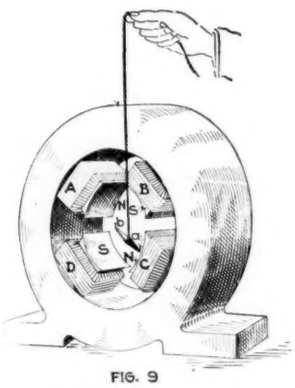


FIG. 9

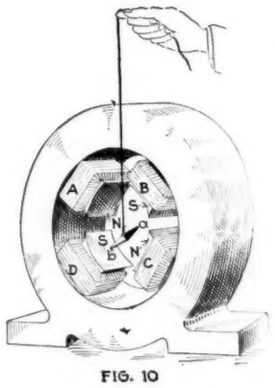


FIG. 10

FIGS. 7 TO 10. USE OF BAR MAGNET TO CHECK THE POLARITY OF POLEPIECES OF A MOTOR OR GENERATOR

windings; if the connections are correct, one end of the needle or magnet will be attracted by one polepiece and its other end by the adjacent polepieces. Figs. 7 to 10 illustrate the method for a four-pole machine. As shown, A and C should be north poles and B and D south poles, or vice versa, when current is passed through them. If the magnet is held near A, the end a will be attracted toward it, but at B the other end b will be attracted. C will attract end a and D end b.

If any of the polepieces shows a polarity contrary to the one it should have, the connections of its coil must be reversed; or if this is not convenient, the coil must be removed from the core and replaced in the opposite direction. If the coils are found removed from their cores, they may all be connected in series, as in Fig. 11, before placing them in the machine. Current is then passed through them and their polarities are tested as before. If any are found incorrect it is a simple matter to reverse them. The connections should then be left intact to avoid errors while handling. When the

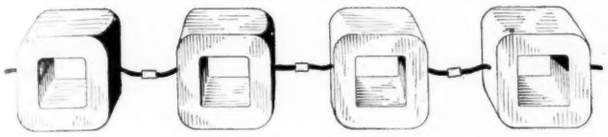


FIG. 11. FIELD COILS READY TO BE TESTED FOR POLARITY BEFORE PLACING THEM ON POLEPIECES

coils consist of a shunt and a series winding, care must be taken to connect together all of one kind separately from the other.

When dealing with interpole machines, it is necessary to consider the connections to be made between the armature brushes and the interpole field windings. To make clear the relation between the direction of current in the armature and the polarity of the interpoles, it should be remembered that the current causes north and south poles to exist in the armature. This condition is illustrated in Fig. 12, in which brush a is positive and brush b negative, creating a north pole at N and a south pole at S. The windings on the interpoles would then have to be connected in such a way that the armature current as it passes through them would create a north pole at A and a south pole at B. The figure indicates what the connections would have to be for the direction of interpole winding shown. Once the armature has been correctly connected to the interpole windings, the connections between them, as at e and f, should never be changed, and c and d are to be considered as the armature terminals. Reversing the current through the armature circuit reverses the polarity of both the armature core and the interpoles; hence like poles still remain opposite each other and consequently there is no objection to such reversal if desired.

To test for correct connections of the interpoles their windings should be short-circuited, care being taken that the short-circuiting connection and contacts are of very low resistance, whereupon the polarity of the armature may be obtained by means of a compass needle. The armature is then to be short-circuited in place of the interpole coils and the polarity of the interpoles determined by means of the magnet. As already stated, the polarity of the interpole should be the same as that of the part of the armature opposite it. If such is found not to be the case, the connections of such coil or coils as are found to be of the incorrect polarity must be reversed.

In the problem of the previous lesson it was required to determine the insulation resistance of an electric heater, the data given being that when the insulation resistance was placed in series with a voltmeter of 11,372 ohms resistance across a source of 114 volts, a deflection of 6 volts was obtained. Let the voltage of the source be represented by E, in this case 114 volts, the deflection of voltmeter by E_1, 6 volts, the resistance of the voltmeter by R_1, 11,372 ohms, and the resistance of the insulation by R, which is to be found. Then from the formula previously given, namely, $R = \left(\frac{E}{E_1} - 1\right) R_1$, we have $R = \left(\frac{114}{6} - 1\right) \times 11{,}372 = 204{,}696$ ohms.

Assume that the armature of a motor is connected as shown in Fig. 1 and that when current flows the drop in voltage across the brushes is 8 volts; also, that minimum deflections of the voltmeter occur when lead b is touched to commutator segments 12 and 13 and that their values are 0.3 volt and 0.2 volt respectively. What values of voltage should be found when lead b is touched to each of the other segments of the commutator? In which coil of the armature winding is

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With the closing of the world war the question of industrial and technical education comes to the fore. Better grounding in the basic principles involved in the practice of a trade makes better tradesmen, but with the recent shortage of labor, many have been promoted to full-fledged journeymen almost overnight. This has not prevailed to so great an extent among operating engineers, but the activities in evening educational work has lagged. It is imperative that the work be again

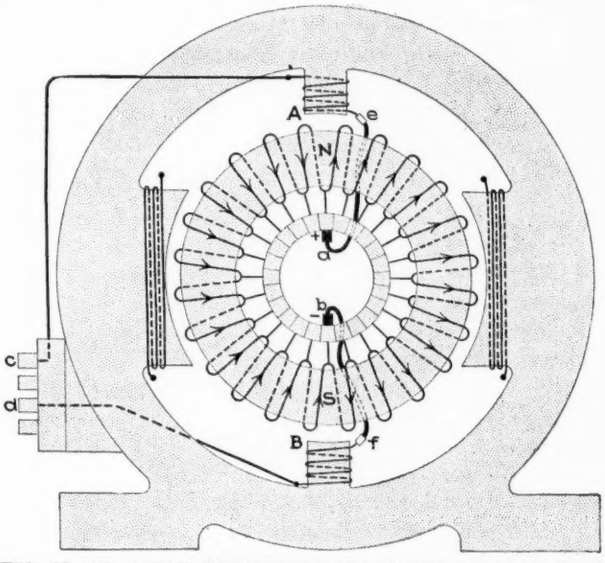


FIG. 12. RELATION BETWEEN POLARITIES OF ARMATURE AND THOSE OF INTERPOLES IN A MOTOR OR GENERATOR

taken up with redoubled energy to make up in part for lost time and to bolster up the weak brother.

In the realm of the technical schools the pendulum has swung from the one extreme—the broad and comprehensive course—to the other—the short specialized or "intensive" training to meet the needs of the times—but it must again swing back toward, if not all the way to, the more thorough grounding. One of the net benefits of the upheaval will no doubt be a longer short course and a shorter long course, a curriculum better adapted to the average requirement, to be supplemented by specialized post-graduate work when final decision is reached as to one's lifework.

Boiler Scale Prevention

In Illinois this is scale prevention week. In each plant the subject should be studied carefully. The following general letter from the Administrative Engineer will serve as an introduction

The importance of this subject can be appreciated better when it is realized that no boiler is without scale and that all scale results in fuel loss. Exceptions to this rule are so few as to be negligible.

The very fact that it is necessary to use a tube cleaner or turbine is sufficient evidence to prove that there is scale. It makes no difference whether the boilers are turbined once a week or once a year, the average thickness of scale is equal to one-half the thickness at the time of removal. Another thing that must not be overlooked is that the only proper place to remove the scale-forming elements is before the water enters the boiler. This is easily possible and the economical thing to do.

Very careful and extensive experimentation in this matter was conducted by Professor Schmidt, at the University of Illinois. Table I is based on the results of his researches.

TABLE I. LOSS OF EFFICIENCY FROM SCALE

Character of Scale	Thickness, In.	Composition	Loss of Eff., Per Cent.
Hard	1/50	Mostly carbonate	5.4
Soft	1/32	Mostly carbonate	7.2
Hard	1/32	Mostly carbonate	8.5
Soft	1/25	Mostly carbonate	8.0
Hard	1/25	Mostly sulphate	9.3
Hard	1/20	Mostly sulphate	11.1
Soft	1/16	Mostly sulphate	10.8
Soft	1/16	Mostly carbonate	11.0
Soft	1/16	Mostly carbonate	12.4
Hard	1/16	Mostly carbonate	12.6
Soft	1/11	Mostly carbonate	15.0
Hard	1/9	Mostly sulphate	15.9

Do not be content with the thought that you are having no trouble with scale. You can have no trouble only when you have no scale. Why wait until you have bagged the boiler, burned out the tubes or wasted a lot of coal before taking action in this matter? Impress upon your memory the fact that the first thin layer of scale is the most injurious. Stated somewhat more scientifically, the rule is that the insulating effect varies as the square root of its thickness. To illustrate, the insulating effect of scale of thicknesses 4, 9 and 16 is 2, 3 and 4. Scale of the thickness of 4 insulates 2, while it requires a thickness of 16 to insulate 4, or four times as much scale to produce twice the insulating effect. To give this matter point and talk in terms of coal, Table II is given.

TABLE II. COAL WASTED BY SCALE

Average Thickness of Scale, In.	Coal Wasted from Every Ton Fired, Lb.
1/50	100
1/32	140
1/25	180
1/20	200
1/16	220
1/11	300
1/9	320

The use of boiler compounds is unquestionably better than no treatment at all, but it seldom, if ever, accomplishes real satisfactory results. If the compound is a chemical and reacts with the scale-forming material in the water, it can only change this material to something else, which is commonly known as sludge. When this occurs, the sludge is deposited on the boiler-heating surfaces as a soft mud-like substance which is not scale, but which has an insulating effect and which, if excessive, may actually result in burning the plates of the boiler. To avoid its becoming excessive, the boiler is blown down frequently, which is a direct loss of heat and waste of coal.

It will be observed from the foregoing that no middle ground is taken in this matter. There is only one right condition and that is perfect cleanliness. If it is thought that there is an objection to properly softening the feed water in advance of pumping it into the boilers, due to the cost of the installation necessary, look over Table II and figure out what it costs now per year with the present water and its consequent scale. In all probability it will be found that the cost of proper water treatment would be paid for inside of two years, including the cost of operation. Water as pure as that in Lake Michigan comes in this class.

In conclusion, remember that it is possible to so purify the water, that no scale will form in the boilers.

EDITORIALS

Reconstruction

THE world is in a state of flux. Into what form will it be molded or wrought? Must there be still another blast of class hatred and internal dissension in which those who have fought side by side will turn upon each other? Will the fluid mass be so suddenly checked and chilled that the structure will be full of internal stresses, ominous of future fracture? Or will there be a quiet and orderly crystallization and welding of its components, each adapting itself to the others so as to make a strong, durable texture, refined and amalgamated by the fury and the torture through which it has passed, potent for the uplift of mankind?

The war has shown that the nation which is most powerful for conquest or for the suppression of an assailant is that nation which makes the most effective use of its resources; that nation in which every individual is doing that which he is best fitted to do and doing it the best he knows how; that nation in which the most efficient processes and methods are employed to win materials from nature, and the greatest skill and economy exercised in their fabrication, distribution and use.

And in the minds of those who have fought and wrought and thought there has developed the sense that the nation which in times of stress is made strong by these processes and conditions will, by the continued application of the same principles, be made strong and powerful and rich and contented in times of peace.

There has been impressed upon the popular mind as never before the conviction that the real measure of a man's worth to society is service rendered, and that this should be the measure of his standing.

The proletariat has got a new grasp upon the significance of efficiency; a glimmering of the truth that the more efficiently all the processes of production, manufacture and distribution are carried out the more there will be for each with the minimum of toil for all; a conception of the fact that if service is the measure of worth, he who serves with the greatest efficiency is of the greatest value.

The war has done more to impress these simple truths than years of education, discussion and propaganda. We have been forced into applying them. We have been wrenched away from habits of thought and of dealing fixed by tradition and years of usage. It is not alone the thrones of Europe that are crashing. The people in movement will not throw off an old feudalism to be ridden by a new. The foundations of the invisible empire are shaking. If the intangible empire of those who have exploited the necessities of the people, as the barons of old exploited land, is overthrown, how shall we construct from its ruins a safe and sane, an efficient and substantial democracy of industry and head off the wreck and riot and disaster to which political revolutions so often lead?

No sane man expects to see the race survive without work. Wood must be hewn and water drawn in order that man may live at all, and more work must be done to meet the growing needs and desires induced by his cultural development. No reasonable man should expect to shirk his share of this labor. It may be in mining coal or tilling the soil, or at the factory bench; it may be in ministering to the health, the intellectual needs, the artistic sense, the desire for amusement and culture; it may be in scientific research and invention that shall combat disease and make more effective the weapons and processes of the eternal struggle; it may be in inaugurating and conducting great industrial and educational enterprises or in directing, through commerce and transportation, the distribution of the products of labor; but in one way or another each unit in an industrial democracy must contribute service commensurate with the degree of sustenance and comfort and luxury that he gets out of life. The world owes no man a living, but it owes every man a chance to make a living.

No reasonable man expects to get the products of another's labor at less than its cost. Nobody objects to paying for food and fuel and clothing and shelter the full cost of production, manufacture and distribution, plus a fair profit to producer, manufacturer and distributor. But when, through control of supply and distribution, prices are imposed which arouse the sense of extortion, discontent is engendered; and when real deprivation follows, as in times of war and revolution and commercial panic, this resentment is likely to be exercised upon the obvious or suspected beneficiaries of the system with the extremes of which France in 1789 and Russia at present are examples.

If, in the new industrial democracy, producer and consumer, labor and capital should realize and admit that the greatest ultimate good of each lay in the good of all, that exaggerated self-interest must be sacrificed to the collective good, that the effort must be to conduct the struggle against nature as the struggle against the enemy has been conducted, by the most efficient, systematic and economical use of our physical resources and man power, would not the problem be simplified?

If it were agreed or decreed that the essentials of life should be sold at cost plus a fair and stipulated profit, labor's quarrel with capital would be transferred to the consumer. The producer would not care what he paid labor because all of his cost is determined by the price of labor. This is true of material and overhead as well as of wages. He would simply pass the increased cost, plus his greater profit on that increased cost, on to the consumer.

But where everybody labors, the consumer is the laborer, and any excessive demand of labor in any particular branch would be resented by the whole community. A little analysis will show that since everything useful is the result of human labor, the price at which commodities would be available to labor would be in direct proportion to the price paid to labor, and that

high wages work to the advantage only of the class whose wages are relatively high; that if wages and salaries and profits were cut in two, the lower return in money would buy just as much as the higher, and the purchasing power of savings, pensions, annuities, etc., be enhanced.

What one of the labor leaders has called "the conscientious withdrawal of efficiency" would be no longer tolerated. A lot of money (labor) has been invested in a plant for manufacturing, say, shoes. If that plant makes a limited number of shoes, the cost of machinery, buildings, etc.—the "overhead"—per pair will be excessive. If the plant can turn out twice the product, the overhead item in their cost per pair will be halved, and if they are sold at cost plus a fair profit their price will be less. The workingman would see that in restricting the output of his machine, that in making the cost of his own labor unnecessarily high, that in the careless or wasteful use of supplies and material he is simply increasing the price of shoes to himself and his fellows, and any disposition to do so would be resented not only by society but by his fellow workers. Replace with this idea the notion that the workman in loafing and wasting material is increasing the demand for labor and curtailing the excessive profits of an extortionate employer, and sabotage will die a natural death. Everybody will see that economy in any of the processes involved in producing a commodity or a service and getting it to him is to his direct personal advantage; everybody will resent any practice, method or system which tends to impair the general over-all collective efficiency, and there will be a universal incentive to improvement in methods and processes which will increase that efficiency and make the battle of life less arduous for all. It will be recognized that a manufacturer has no right to run his power plant wastefully, because it is not his own money that he is wasting. He is making his product cost more to the consumer. He is wasting man power in the mining and transportation of unnecessary coal. He is drawing extravagantly upon a valuable national resource and making coal scarcer for everybody. An isolated plant has no right to run when the service that it renders could be more efficiently rendered by a central station, and a central station has no right to absorb an isolated plant that can furnish light and heat and power more efficiently than they can be provided if the current is taken from its circuit.

In some such spirit and upon some such ground can we not meet and in the reconstruction which is to come weld together a nation of which the watchword is efficiency and in which service is the measure of worth?

Plant-Improvement Reports To the Management

ELSEWHERE in this issue, in his paper on "Fuel Conservation Reports to the Management," Joseph G. Worker makes one statement that power-plant engineers should read over a few times and then reflect upon the import of it; namely, "A management is not going to spend money just because it is another's idea that the expenditure will remedy difficulties."

Of course everyone who reads it agrees with it; but the fact is, too many engineers do not include such specific data and information with their reports as shall convince the management of the recommendations made or of the seriousness of the situation reported. Just the kind of report we have in mind as a good report is given by Mr. Worker in his paper.

Tempting the Engineer

Following is an exact copy of a letter received by a Chicago engineer:

> Dear Sir. I. would inform you that I. stardet in the Boiler Setting for my self inn Stocker work Arches ore repairing inFire ore Comen Brick work Day ore Contrackt for 1 Bracklayer and I Labor $2 per Hour and will give you 10c Commission per Hour.
>
> Hoping you will give me a change I. remain yours.

It is gratifying to report that the solicitor did not get his "change."

An apparatus for the direct measurement of chimney losses was described by Monsieur Chopin at a recent meeting of the Paris Academy of Sciences. The amount of heat voided to the chimney varies directly as the difference between the temperature of the chimney contents and that of the outside air, and inversely as the percentage of CO_2 by volume. The temperature difference is measured by a thermocouple, and the other factor by a change in the electrical resistance of a solution of caustic soda caused by the absorption of carbon dioxide and the production of sodium carbonate. Each of the factors is thus reduced to a galvanometer reading, and the point of intersection of the two galvanometer needles is read off on a series of curves plotting the percentage heat loss.

Nineteen mines in Pennsylvania and Alabama have been added to the list ordered closed by the Fuel Administration on the ground that coal was improperly prepared. This brings the total of closure orders, up to November 18, to one hundred and ninety-nine. After last year's experience in burning dirt, nobody will object to the shutting down of such mines as attempt to evade the clean-coal order.

William H. Barr, president of the National Founders Association, speaking at the annual convention recently, declared that the first and greatest post-war problem before them was the liquidation of labor. The labor problem will never be solved by a few employers who meet by themselves to determine what they will do for labor. The indications are that labor is going to have something to say about the matter.

Opening windows to cool overheated rooms without controlling the heat supply reminds one of the Indian saying: "Indian build little fire and sit close to keep warm. White man build big fire then sit way back to keep cool."

All restrictions on brass tubes were released by the War Industries Board on November 26, but there is no reason why we should not keep right on being saving of them.

All storage limitations on bituminous coal are off. If you cannot store all you want to, you can store all you can get.

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellow-engineers how you have saved coal. "Power" will pay for good articles that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

Will the Saving Continue?

In the editorial on page 783 of the Nov. 26 issue of *Power*, entitled "Will the Saving Continue?" two probable reasons are given as to why some steam plants have been run uneconomically in years past. One was that the engineers were indifferent as to the showing they made, and the other was that the employer could not be sufficiently interested to supply the instruments necessary to permit the engineer to determine when he was getting the best results from his plant.

This caused me to recall several steam plants that I have operated in times past. These plants were fitted with water columns, steam gages and safety valves, and the general run of valves and fittings, but as to instruments for assisting in determining when the coal was being burned to the best advantage, there was none. As a matter of fact, in those days the owners were satisfied if the engines were started up in the morning and kept running until quitting time at night. I suppose that this condition exists in many plants today, but it should not be so.

In many instances if an ambitious engineer wants to know how much coal he is burning per day, the chances are that it will be necessary to borrow from some department in the works a scale, on which to weigh the coal. Having the weight of coal, he wonders what the water evaporation may be per pound of fuel, but as there is no meter connected directly to the boiler-feed pump, this knowledge is denied him and the only way is to figure it from an indicator diagram, which is a makeshift, to say the least. The indicator diagram will give the horse-power developed, and with that and the coal weight, the coal consumption per indicated horsepower developed may be determined.

That knowledge does not tell the story that the engineer wants to know. The boiler may generate hundreds of pounds of steam that is used in process work through the manufacturing plant, and therefore there is no way, with the apparatus at hand, by which the evaporation per pound of coal can be determined.

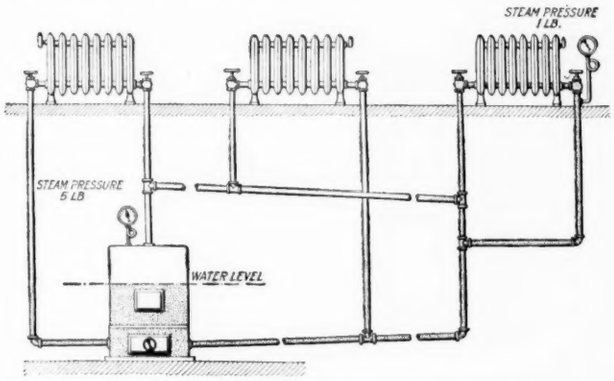
Fortunately for steam-plant owners and their engineers, or at least some of them, the fuel situation during the last year or more has brought home to them the value of a pound of coal. With but a few tons on hand and practically none in sight, steps had to be taken to economize so as to make the supply go as far as possible. In this way wastes have been shown up, and although prices may drop it seems unlikely that wasteful methods will be allowed to return, especially when the owners realize that money can be made by saving coal.

Will the saving mentioned in the editorial continue? In most plants it doubtless will, and the probabilities are that even greater savings will be made. An engineer who takes any pride in his job will work to make a good showing, and as mentioned in the editorial, if he doesn't there will be others to take over the job who will.

Pittsburgh, Penn. W. B. JEFFERSON.

Faulty Design in Heating Systems

My experience with heating boilers shows that when the apparatus is installed mistakes are often made which cause a great many failures. One of the most common is that the distance vertically that should be allowed between the water line in the boiler and the lowest point in the horizontal steam supply above the boiler is not carefully considered. The loss of pressure



PRESSURE DROP IN LINE FLOODED RADIATORS

in the supply pipes between the boiler and the extreme end of the return pipes will allow the water to rise until a column equal in weight to the difference in pressure has accumulated in the system. The water sometimes reaches the main steam pipe and first-floor radiation, as shown in the illustration. Equalizer connections at the boiler will not remedy this mistake.

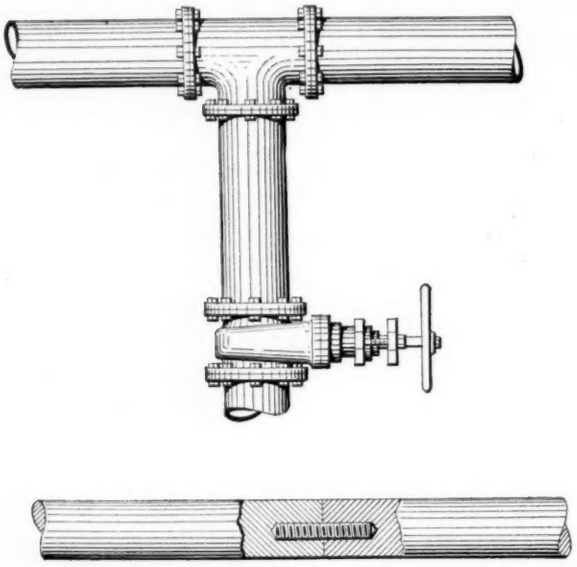
Buffalo, N. Y. THOMAS SUTCLIFFE.

Settling Chamber in Pipe Line

A double-suction volute pump receiving water at 20 lb. pressure and delivering it at 125 lb. gradually failed to maintain its discharge pressure. On taking the pump apart, I found that small stones had clogged the impeller, reducing the openings to about half. To prevent future difficulty I cut the intake line a short distance from the pump and put in a tee, as shown in the

upper part of the illustration, with a 12-in. drop pocket and a gate valve on the end, forming a chamber on the intake line into which any heavy foreign substance could fall. By blowing down once a week the trouble was done away with.

One of the rods of a little steam pump broke under the valve-lever operating spool, there being a ⅜-in. hole through the rod to hold the spool in place, which weakened it. Not having a spare rod and as it was necessary that the pump be kept in service, I drilled a ½-in. hole parallel with the rod in each end where it was broken and tapped them out to ⅝, put in a continuous-thread stud and screwed it up tight until the rod ends came together, as shown at the lower part of the illustration. The pump was kept running in this way until another rod was made.



SUCTION SETTLING POCKET AND PUMP-ROD REPAIR

O. W. MANN.

Provo, Utah.

Unsymmetrical Indicator Diagrams

Regarding the best use of an indicator on a steam engine the following may be of interest. The engine was a tandem compound of the type built for medium rotative speed, with heavy reciprocating parts and had been entirely satisfactory for the service for which it was designed, but when put to high-speed work—direct-connected to a generator—it gave constant trouble in heating and "pounding" for lack of sufficient compression cushion. The flywheel carrying the inertia governor and the governor itself was, of course, in a fixed position and the exhaust lap of the valves could not easily be increased. The way out of the difficulty was pointed out by the indicator. The connection between the valves was shortened and the main rod lengthened until the high-pressure diagram showed a lot of compression on the head end and practically none on the crank end, and the low-pressure diagram in turn showed greater compression on the crank end and almost none at the opposite end. In this way adequate compression was obtained at one end of one cylinder and at the other end of the other cylinder to suit the increased speed.

When the condition for best operation was found a set of diagrams were inked in and pasted in the logbook for future reference—to show just how much *wrong* the valves had to be set to be *right*.

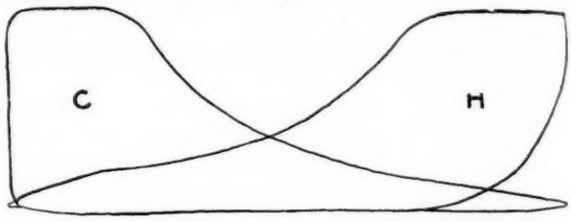


FIG. 1

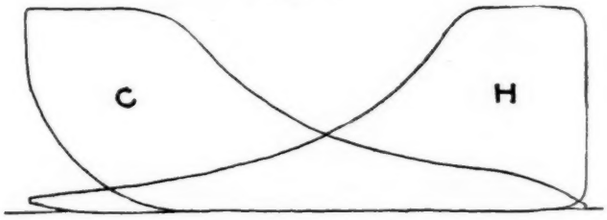


FIG. 2

ALL COMPRESSION AT OPPOSITE ENDS OF CYLINDERS

The moral, of course, is that the most shapely or symmetrical indicator diagram is not necessarily the one that will produce the best running engine.

New York City J. LEWIS.

Trouble with Belt Tighteners

Two belt tighteners were installed last summer on two engine drives, as shown in Fig. 1, to avoid the loss of time caused by shortening the belts. Fig. 2 is intended only to show the type of tightener and not the make. These belt tighteners have not been satisfactory so far. The construction is light and had to be reinforced, and they cannot be kept "hard down" on the belt, but are used only to take the flap out. As soon as the pulleys are screwed down tight on the belt and there is a large or sudden change of load, the belt runs to one side and is in danger of running off. Some of our me-

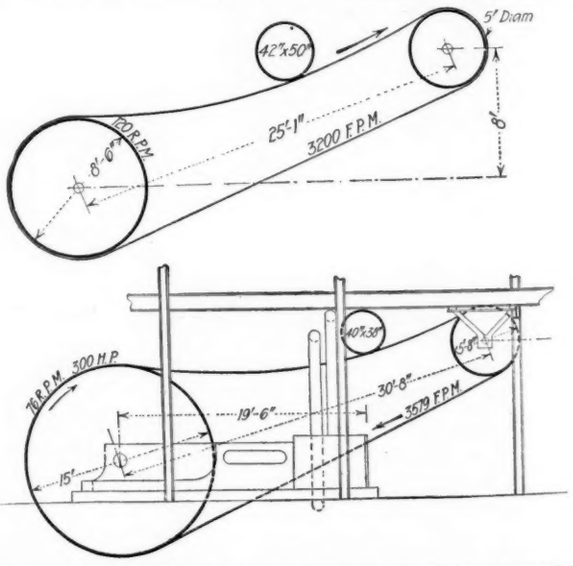


FIG. 1. CONDITIONS UNDER WHICH TIGHTENERS WORK

chanics say this trouble is caused by the tightener pulleys being crown-faced; others say that the rigid tightener is not the type needed, but that a swing or floating one should be used. We would be glad to have you publish this in order to bring out a general discussion. We have not been able to overcome the difficulty and have to

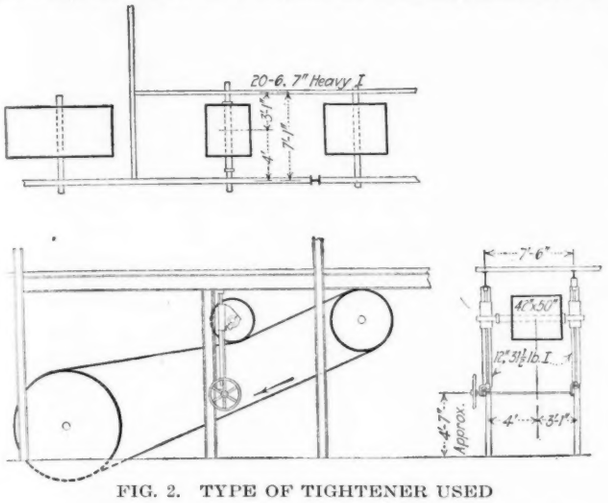


FIG. 2. TYPE OF TIGHTENER USED

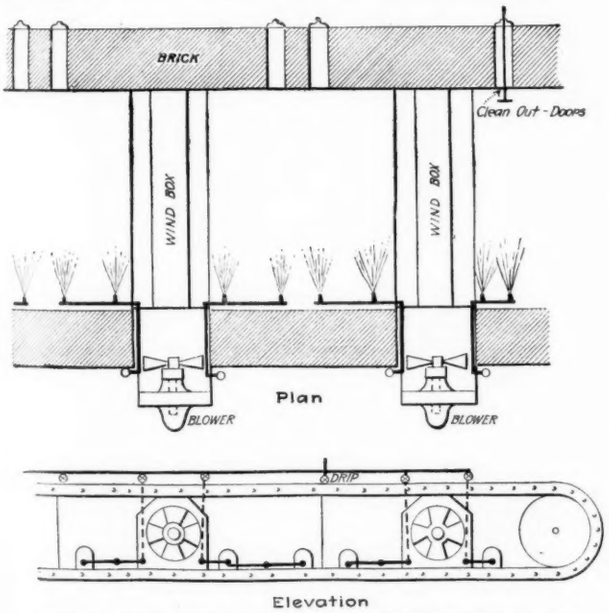
take up the belt as frequently as before, as the tightener pulley barely touches it, and, as stated, it is kept only to avoid the excessive flapping of the belt when the load changes. Both drives are subject to sudden and extreme changes in load.

J. S. ECKERT.

Blissfield, Mich.

Clearing Windboxes of Siftings

The illustration shows how, by the use of steam jets, I clean coal siftings out of the wind compartments of a chain-grate stoker when burning small anthracite.



STEAM JETS USED TO CLEAR STOKER WINDBOXES

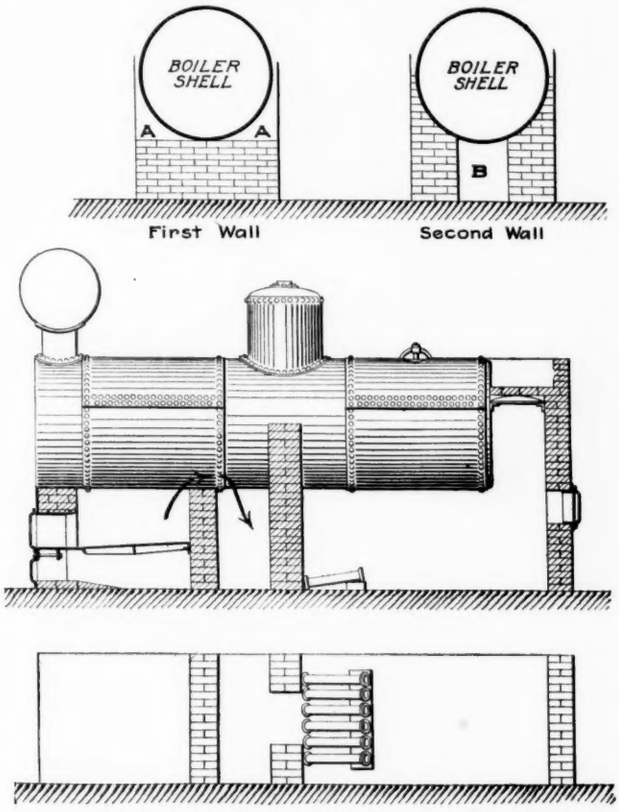
The main steam line is ¾ in., with nozzles reduced to ⅜ in. The main valve is kept closed and the drip valve open when the jets are not in use, to make sure that no water drips under the grates. When being put into operation, the drip valve is kept open until all water is blown out of the piping, then the compartments are blown one at a time for about one minute and thoroughly cleaned. A short-handled hoe is used to remove the siftings from near the cleanout door.

By providing for this system when the boiler is being bricked in, the piping could be more direct, thereby saving considerable work and cost. With very small anthracite the compartments are cleaned once a day, but with larger sizes every other day is sufficient. This method of cleaning has been in use in our plant about five months and is entirely satisfactory. Too much dirt should not be allowed to accumulate before blowing, and the steam line should be kept thoroughly drained to avoid wetting the mass so it can't be blown out.

Carteret, N. J. CHARLES A. PHILLIPS.

Smokeless Furnace for Volatile Coal

The special furnace shown in the illustration was designed by the chief engineer of the Carpenter Paper Co., Omaha, Neb., to prevent the emission of smoke while burning smoky soft coal. The bridge-wall is extended up to the boiler shell, and the spaces at the two sides of the boiler form the passages for the flame. A second wall, built about two feet farther back, extends all the way up around the boiler, but has an opening below the boiler as shown. In the remaining part of the combustion chamber there are six or eight lengths of 4-in. sewer pipe laid side by side with their after end raised somewhat.

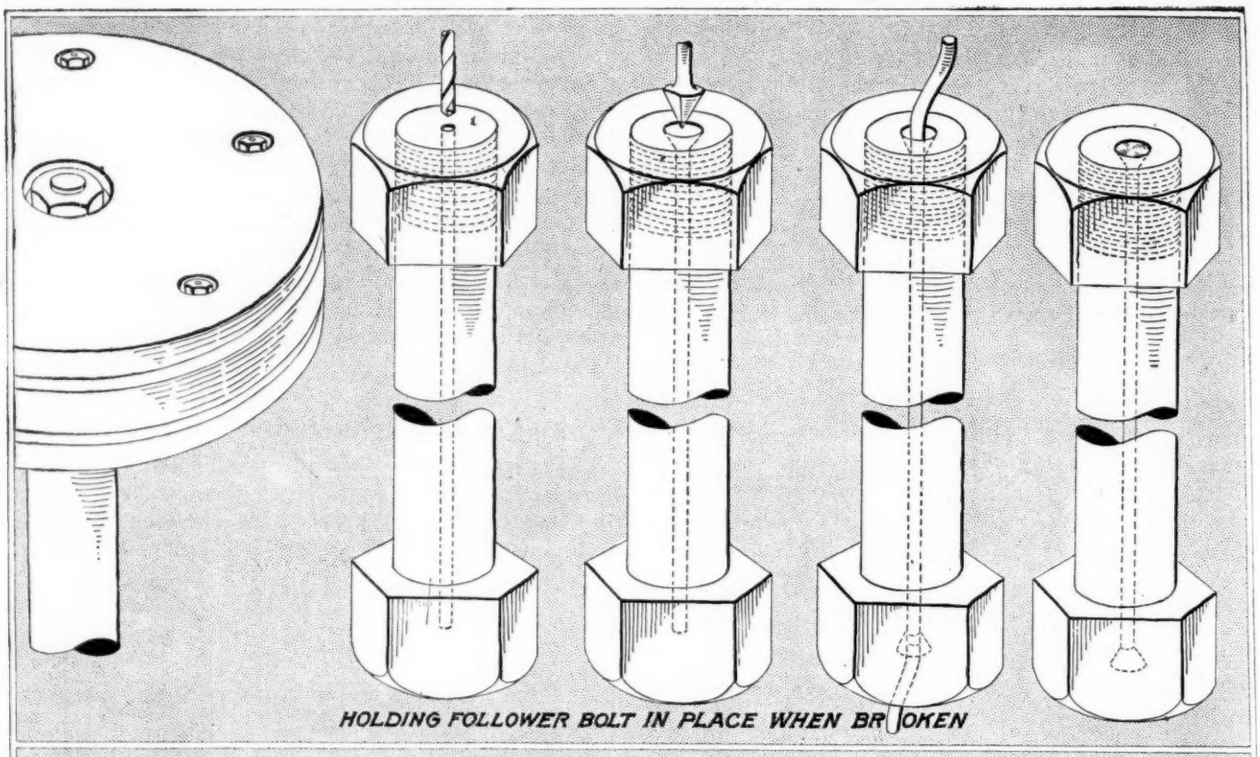


DETAILS OF SMOKELESS FURNACE FOR WESTERN COAL

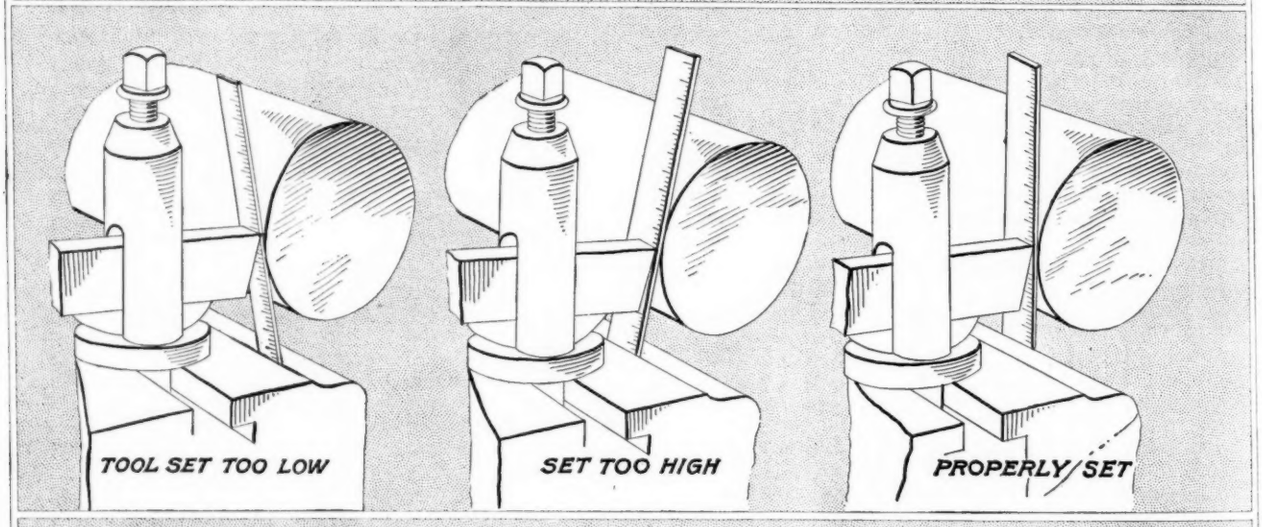
This furnace has been in satisfactory service for about a year. There is ample draft, in fact, the draft does not seem to have been diminished at all.

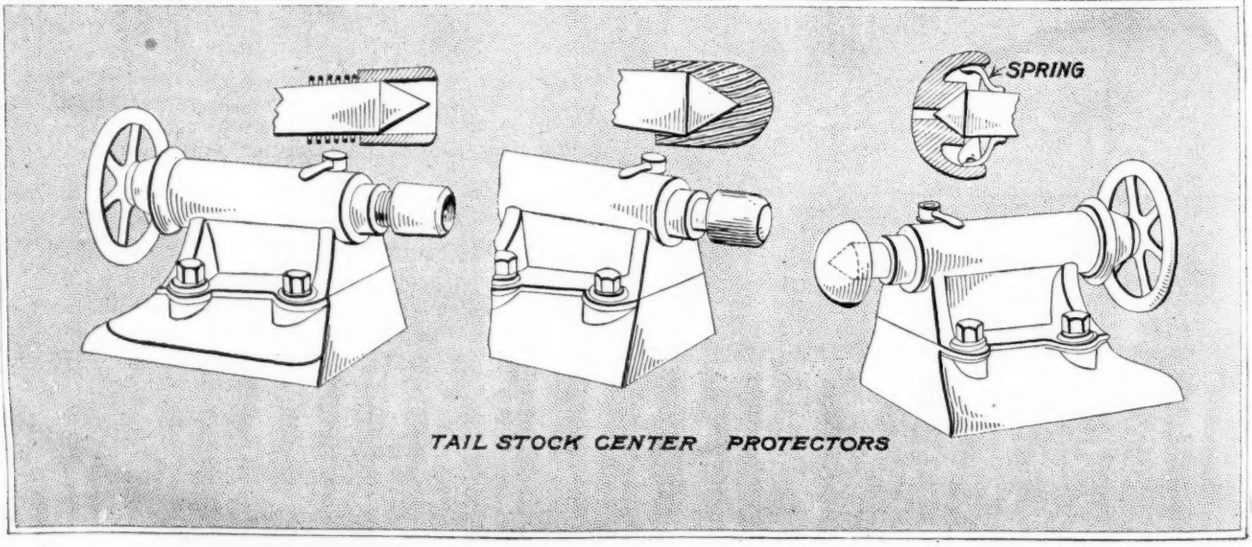
Omaha, Neb. EMIL WEYERMAN.

Useful Kinks for the Power-Plant Engineer



HOLDING FOLLOWER BOLT IN PLACE WHEN BROKEN





TAIL STOCK CENTER PROTECTORS

INQUIRIES OF GENERAL INTEREST

Water Discharged Through Orifice—What number of cubic feet of water under a gage pressure of 100 lb., and of 150 lb. per sq.in., will issue per minute into the atmosphere, through a 1-in. square opening in the side of a large pipe whose shell is ¼ in. thick? R. G. B.

The theoretical velocity of water flowing from an orifice is the same as the velocity of a falling body that has fallen from a height equal to the head of water, and is given by the expression $v = \sqrt{2gh}$, wherein v = velocity in feet per second, g = acceleration of gravity = 32.16, and h = the height in feet. Assuming that the opening referred to is equivalent to an orifice in thin plate, the actual velocity at the smaller section of the *vena contracta* is substantially the same as the theoretical velocity, but the velocity at the plane of the orifice would be about 60 per cent. of the theoretical. As a pressure of 100 lb sq.in. would be equivalent to a head of $100 \times 2.3 = 230$ ft., the actual velocity of discharge through the aperture would be $0.6\sqrt{2} \times 32.16 \times 230 = 73$ ft. per sec., and for an aperture 1 in. square the discharge would amount to $73 \times \frac{1}{144} \times 60 = 30.4$ cu.ft. per min. Since the velocity is as the square root of the head, the quantity discharged for a pressure of 150 lb. per sq.in. would be $50.4 \times \sqrt{150} \div \sqrt{100} = 37.23$ cu.ft. per minute.

Critical Value of Frequency in A. C. Current—What is meant by the expression "critical value of the frequency" used with reference to a.c. currents, and what are the differences between resistance, reactance and impedance? H. F. S.

The expression "critical value of frequency" would apply to the condition of resonance in an a.c. circuit that contains inductance and capacity. When dealing with alternating current we are confronted with three properties, found to exist in the circuit through which the current passes. They are resistance, inductance and capacity, all of which restrict the flow of current. Inductance gives rise to what is known as a lagging current and capacity to a leading current, but resistance has no effect in advancing or retarding the current. Inductance and capacity of a circuit give rise to what is called the reactance, the general expression for which is

$$x = \sqrt{\left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$$

where x is the reactance, L the inductance, C the capacity and f the frequency of the alternating current supplied. Impedance (Z) is the result of resistance, inductance and capacity and the expression for it is

$$Z = \sqrt{R^2 + x^2}$$

As the value of the current is $I = \frac{E}{Z}$, where I is the current flowing in the circuit, E the voltage applied to it and Z the impedance, it follows that the maximum current would flow if the value of x were zero. The value of R is a fixed quantity, but the value of x depends on the frequency, as can be seen from the expression for it. If we could change the frequency so as to make $2\pi fL = \frac{1}{2\pi fC}$, x would become zero, and this condition is known as resonance. In order to secure this result we must have $f = \frac{1}{2\pi\sqrt{LC}}$ and the value of f so obtained is the critical value of frequency.

Turning Exhaust into Steel Stack—We are annoyed by exhaust steam from our engine being blown against the side of our factory building. Could not the exhaust be discharged into the 40-ft. iron smoke-stack and with advantage to the draft? A. R. S.

The proper method of abating the nuisance from the exhaust steam would be to raise the exhaust pipe 4 or 5 ft. higher than the sides of the building and provide an exhaust-pipe condenser head with a drip pipe returned to a point on the ground where the small amount of vapor from the condensation would be unobjectionable. Discharging the exhaust steam into the smoke-stack would be of little if any advantage in improvement of the draft and, besides causing the interior of the smoke-stack to rust more rapidly, would be likely to result in discharge of moist clots of soot that would be more objectionable than the present annoyance of exhaust steam.

Horsepower of Locomotive Boiler—What is the horsepower of a locomotive type boiler that has 60 in. diameter of waist, furnace 4 ft. 6 in. x 5 ft. x 4 ft. 6 in. high and contains 82 flues 3 in. diameter by 13 ft. long, with safety valve set at 150 lb.? W. L.

The horsepower rating of size depends on the number of square feet of heating surface, and the usual commercial rating is with allowance of 10 sq.ft. of heating surface per horsepower.

Reducing all dimensions to inches, the heating surface of the furnace including fire-door and flue-sheet openings would be $54 \times 60 + 2 \times 54 \times (54 + 60) = 15{,}552$ sq.in.

The internal diameter of a 3-in. flue is 2.782 in., and the internal cross-sectional area is $2.782 \times 2.782 \times 0.7854 \times 6.079$ sq.in. Hence the heating surface removed by flue openings would amount to $6.079 \times 82 = 498.5$ sq.in., and allowing 200 sq.in. for the fire-door opening, the net heating surface of the furnace would be $15{,}552 - (498.5 + 200) = 14{,}854$ square inches.

The internal circumference of a 3-in. flue is $2.782 \times 3.1416 = 8.74$ in., and the heating surface in the flues would be $8.74 \times 13 \times 12 \times 82 = 111{,}802$ square inches.

The gross area of the smoke-box flue sheet would be $60 \times 60 \times 0.7854 = 2827.4$ sq.in., and deducting flue openings, the net area is $2827.4 - 498.5 = 2329$ sq.in. Hence the total heating surface would be:

For furnace	14,854 sq.in.
For flues	111,802 sq.in.
For smoke-box flue sheet	2,329 sq.in.
Total	128,985 sq.in.

and allowing 10 sq.ft., or 1440 sq.in. per hp., the strict size rating of the boiler would be $128{,}985 \div 1440 = 89.5$ hp. The evaporative power or steaming capacity that can be developed depends on the amount and intensity of heat received by the heating surfaces, the amount of soot and scale and the efficiency of covering or other means provided for the prevention of radiation of heat from the boiler. The allowance of 10 sq.ft. of heating surface per boiler horsepower is a rating based solely on the dimensions, and with ordinarily good fuel, firing and draft it is generally assumed that for boilers of ordinary forms and proportions this amount of heating surface is capable of developing a standard boiler horsepower, which is equivalent to the evaporation of 34½ lb. of water from and at 212 deg. F. per hour, making due allowance for the actual temperature of the feed water and heat contained by the steam generated.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Annual Meeting of the American Society of Mechanical Engineers

THE public sessions of the thirty-ninth annual meeting of the American Society of Mechanical Engineers opened with a large attendance in the auditorium on the evening of Dec. 3. In his address, "Broader Opportunities for the Engineer," Charles T. Main as president of the society dealt with the broader opportunities that await the engineer in welding America into that new and more nearly perfect symmetry and unity which will assure to each and to all the utmost safety and the highest liberty. "Probably most of us," he said, "have a vague knowledge of the many issues involved and an indefinite conception as to the effect of the war on the political, social and business conditions of the world, but we can surely predict that there will be a remolding of all these so that our country will be one of greater unity of purpose and desire with a more spiritual and less materialistic view of life and greater unselfishness in the service of our country and mankind. A review of what engineers have done in the war and of the activities of the society and its related bodies leads to a vision of the broader opportunities of the engineer. If this can be accomplished at this particular time and for this particular occasion, why should we not now and in the future exert our influence and direct our energies toward matters of broader interest?"

He quoted Past President Hollis, who said: "In the changes that are coming the engineer can no longer dwell within his technical shell, and he must prepare himself to become a citizen of the world upon whose shoulders great economic and social burdens are placed"; and Professor Kimball, that, "If we are faithful to our duties we shall be of greater importance politically and socially, but to accomplish this we must broaden our vision and get about our business, which is the industrial organization of our country."

It should be the aim of the engineer to render the best possible service in a broad sense. The true success of a man is not measured by the accumulation of money, but by the accomplishment of work which adds to the general good of mankind and the advancement of the profession. Some of his epigrams were: "We were unprepared for war which was a possibility, and we are unprepared for peace which is a certainty." "The contests will not be of battle but of industry; the conquests will not be of territory or thrones but of markets."

He urged the appointment of engineers upon governmental committees and commissions and suggested that engineering problems be submitted to Engineering Council or that that Council offer its services to every congressional committee having problems of an engineering nature to report upon.

Officers Elected for the Ensuing Year

Following President Main's address, the report of the election of the following officers for the ensuing year was read: President—M. E. Cooley, professor of mechanical engineering and dean of the College of Engineering and Architecture of the University of Michigan; vice presidents—F. R. Low, editor of *Power*, New York; H. B. Sargent, president, Sargent & Co., New Haven, Conn.; and J. A. Stevens, consulting engineer, Lowell, Mass.; managers—C. L. Newcomb, general manager, Deane Works of the Worthington Pump Co., Holyoke, Mass.; F. O. Wells, president, Greenfield Tap and Die Corp., Greenfield, Mass.; and C. R. Richards, dean of the College of Engineering and director of the Engineering Experiment Station of the University of Illinois, Urbana, Ill.; treasurer—W. H. Wiley, president, John Wiley & Sons, New York.

Honorary membership was conferred on Charles M. Schwab and Orville Wright. This was made the occasion of numerous humorous and touching reminiscences by "Uncle John" Brashear of his long and pleasant association with Mr. Schwab, who replied in a similar vein. The reception to the incoming president with the newly made members in line was followed by dancing and refreshments.

At the Wednesday morning session in the auditorium the proposed amendment to the constitution providing that the nominating committee for officers of the society in the future be selected by the voting membership instead of by appointment by the president was taken up. A motion that this amendment be submitted to letter ballot was carried unanimously. Reports of various standing and special committees, including the committee on standardization of flanges, were presented. The total budget for the coming year is $236,000, which is well within the income of the society. The program committee reported strongly in favor of a wider range of subjects for papers for discussion by the society. It was also reported that the society had purchased and undertaken the publication of the *Engineering Index*. It is proposed to extend the scope of the *Index* in connection with the *Journal* and the technical library of the society, making it the most complete publication of its kind ever attempted.

The membership of the society is now over 10,000 as a result of the untiring work of the membership committee.

During luncheon hour Dr. George W. Kirchwey, formerly dean of Columbia Law School, delivered an address on "A Message from the Legal Profession." He set forth the present conditions and the work confronting the engineer and engineering societies in the immediate future in reconstructing the whole world; in fact, not merely structurally, but in the relation of employer and employee with justice to both. The address brought out liberal discussion both formal and informal. It is hoped that space in a future issue will permit of a full abstract of this paper as well as others of the meeting. At 2 p.m. simultaneous sessions were held. At the machine-shop session in the auditorium the papers presented were "The British Engineering Standards' Associations," by C. le Maistre, its secretary; "Work of the British Engineering Standards' Association on Screw Threads and Limit Gages," by Sir Richard Glazebrook; "Present Practice in Thread Gage Making," by Frank O. Wells; "Measurement of Thread Gages," by H. L. Van Keuren; "Standards for Large Taper Shanks and Sockets," by Luther D. Burlingame.

Joint Session with Refrigerating Engineers

The joint session with the American Society of Refrigerating Engineers was held at 2 p.m. Dr. Mary E. Pennington, of the Food Research Laboratory, United States Department of Agriculture, read a highly informative and interesting paper on the "Development of a Standard Refrigerator Car," in which she outlined the experimental methods adopted to obtain data for the construction of what is now termed the United States standard refrigerator car. The effects of different thicknesses of insulation, different arrangements of ice bunkers, etc., were found by constructing and testing two cars that were duplicates in all respects except one—the particular variable to be examined. In this way the several features of the standard car were determined, one by one.

Following Dr. Pennington, the chairman, Dr. D. S. Jacobus, introduced David Moffat Myers, of the Conservation Bureau of the United States Fuel Administration, who gave a brief talk on the origin, accomplishments and future of the fuel-administration organization. He declared that under the inspiration of the slogan, "Maximum production with minimum waste," coined by Dr. Jacobus, the saving in coal in power-plant operation since May 1, 1918, had been at the rate of 7,000,000 tons a year. He said further that although the efforts of the Fuel Administration at the beginning had been regarded as a form of paternalism, the work accomplished had been so valuable in every respect that numerous letters were now on file indorsing the work and earnestly requesting the continuance of the organiza-

tion in peace times. He said that the statistical division of the organization would hereafter be under the direction of the U. S. Geological Survey and that the work of the fuel conservation bureau would be taken over by the Bureau of Mines.

C. A. Graves, Fuel Administrator of New York, expressed his thanks to the members of the society for their aid and coöperation. He gave some interesting figures taken from the returns to a large number of the questionnaires sent out to power plants, showing the particular points of weakness, as follows:

Item	Relating to	Assigned Value	Average Given
a	Fuel records	9	3
b	Measuring feed water	15	4
c	Air supply	12	5
d	Clean heating surfaces	12	8
e	Tight settings	20	15
f	Insulation	7	5
g	Exhaust steam	15	11
h	Supervision	10	5
		100	56

In other words, the average rating of the plants covered by the answers examined was 56 out of a possible 100.

E. N. Trump pointed out that a vast collection of data had been obtained by the Fuel Administration and that these data should be analyzed and then each plant should be given the specific suggestions it needs to improve its operation.

E. G. Scott, commenting on the waste in industrial power plants, attributed it to the fact that the coal bill was but a small fraction of the total expense and therefore did not command the close attention of the management.

J. A. Whitlow, Administrative Engineer of Missouri, remarked that in factories the power plant was merely incidental, whereas in central stations the coal bill formed the larger part of the operating cost. In Missouri there was no threat of fuel shortage and the results obtained were therefore the result of a spirit of coöperation.

Address of the Illinois Fuel Administrator

Joseph Harrington, Fuel Administrator for Illinois, spoke on the importance of clean heating surfaces. In connection therewith he described a system of soot cleaning that was efficient, cheap, required little labor and obviated reducing the duty of the boiler. The fire is put in good condition, with plenty of incandescent surface, and then common salt is sprinkled over it. The heat dissociates the salt into sodium and chlorine gas, filling the furnace with dense white fumes. The sodium burns with oxygen and passes off; but the chlorine gas has affinity for the soot-forming material and so combines with it. The effect is to cause the soot to shrivel, become spongy and fall or simply disappear. In reply to questions as to the quantity of salt used he said that from 5 to 6 scoopfuls of coarse salt were used in a 300-hp. Stirling boiler fitted with Green chain grates and burning Illinois coal. The salt was thrown in, one scoopful at a time. It required about half an hour for a scoopful to disappear. By spreading one or two scoopfuls of salt during the day the boiler can be kept free from soot continuously. Examination by a chemist showed that neither the boiler nor the brickwork was in any way affected adversely by the use of the salt.

The concluding paper of the session was presented by Victor J. Azbe on the subject of "Refrigerating Plant Efficiency." It will be abstracted and published in a later issue of *Power*. The discussion of this interesting paper was limited, owing to the lateness of the hour.

E. N. Trump and Professor Wood spoke on the advantages of the uniflow type of engine in refrigerating work. Mr. Ormsby briefly referred to ammonia leaks. He argued that a successful bonus system to prevent excessive leakage required some method of making an inventory of the amount of ammonia in the system without waiting until the yearly overhaul. Mr. Hill pointed out that the use of variable-speed drive in refrigerating plants was found to be unnecessary and so the solution of the power problem was the use of direct-connected synchronous motors, running at as low as 50 r.p.m. Mr. Horn confined his remarks to rates for electricity for refrigerating plants. He showed that inasmuch as the refrigerating plant requires its maximum power during the season of light load for the central station, a particularly attractive rate could be made to ice and cold-storage plants. The discussion was concluded by Joseph Harrington, who referred to the boiler room of the refrigerating plant. He declared that no one part of the fuel-conservation program could be singled out as of more importance than another, but that all should be taken into account at the same time.

On Wednesday evening an illustrated lecture on "The Achievements of Naval Engineering in the War" with special reference to the Bureau of Steam Engineering of the Navy Department, by Lieutenant-Commander William L. Cathcart, U. S. N. R. F., was largely attended. Following this lecture motion pictures were shown of "The 50-Caliber 14-Inch Navy Guns with Railway Mount" by Lieutenant-Commander D. C. Buell, U. S. N. R. F.

A report of the sessions of Thursday and Friday will appear in next week's *Power*.

Electrical Engineers Meet at Toronto

A convention of the American Institute of Electrical Engineers was held at the Engineers' Club, Toronto, Nov. 22 and 23, which was attended by about 150 members. In the absence of President C. A. Adams the chair was taken by Arthur H. Hull, of Toronto, assistant engineer of the Ontario Hydro-Electric Power Commission. Mr. Hull read a highly interesting paper on "Electrical Power Development in Ontario," dealing more particularly with the work of the commission and the extensive operations now in progress in the construction of the canal eight miles in length to convey water from above the falls to a new generating station at Queenston. When the commission in 1908 contracted for 100,000 hp., it was thought that this would supply the demand for many years, but it had proved altogether insufficient, and the new development provided for an initial installation of 200,000 hp., and future plans contemplated the use of 400,000 hp. To show the effect of utilizing the greatest possible head of water Mr. Hull pointed out that about 30 hp. will be developed for each cubic foot per second at Queenston, as compared with about 14 hp. from existing plants at Niagara Falls. "Electrical Equipment of the Canadian Northern Railway Tunnel at Montreal" was the subject dealt with by W. G. Gordon, of the Canadian General Electric Co. of Toronto, who emphasized the advantages of the electrical service in handling trains and the economy effected thereby. A paper accompanied by illustrations was given by S. Svenningson, of the Shawinigan Water and Power Co., descriptive of the transmission of the 100,000-volt line across the St. Lawrence over the longest transmission span in the world, showing in detail the manner in which this great engineering feat had been accomplished. The principal feature of the dinner Nov. 22 was an eloquent patriotic address by Sir Robert Falconer, president of Toronto University, who told of his experiences overseas and praised the part taken by the United States in conjunction with the Allies. On the 23d a visit was paid to the Leaside munitions plant, the British Forgings Works and the laboratories of the Hydro-Electric commission, and a luncheon was held at the rooms of the Board of Trade.

According to *The Engineer*, paper substitute driving belts are now being introduced into German workshops, and some particulars of them are given in the *Bulletin des Usines de Guerre*. The paper is cut into narrow bands, which are then spun. The belts are made by weaving or braiding. Woven-paper belts are of two kinds—paper-fabric and paper-thread belts, the former type being the most frequently used. The fabric is first cut into bands 40 m. (12.2 ft.) long, which are subsequently made up according to the desired width and thickness. A core of strengthening material is interposed, either cotton or sheet metal, though more recently these cores have consisted of paper, thread and metal wires interwoven. The core is surrounded with the paper strips and the whole sewn with strong thread. Belts so prepared are said to be very flexible and to wear satisfactorily. Woven-paper belts have a tensile strength of from 100 to 125 kilos (220.5 to 275.6 lb.) per centimeter (0.3937 in.) of width.

Engineering Societies Establish Employment Bureau

At a special meeting of the Engineering Council called on Nov. 21 to determine approximate limitations on its field of activity and to consider a working program, it was decided that an Engineering Societies' Employment Bureau should be established at once, principally to meet the new need which has arisen for an agency to aid engineers who have been in military service to find suitable positions. The four secretaries of the Founder Societies of the United Engineering Society are appointed as the board of managers, and Walter V. Brown is made secretary in immediate charge.

This action was taken as the result of the joint meeting held the previous day by the present secretaries and the American Engineering Service. The resolutions further provided that the American Engineering Service be instructed to turn over its entire office equipment and records and instruct its operating staff to report for further service to the bureau when organized, and that thereupon the American Engineering Service be automatically discharged. It was determined that the work should be started on the basis of no charge, with headquarters in the Engineering Societies Building, New York.

The work of the American Engineering Service was cited as having been of inestimable value to the Government through the coöperation between the four Founder Societies and the Government, and a resolution was passed expressing high appreciation of the accomplishments of George J. Foran and his associates during his chairmanship. As defining its field of activity, the following resolution was passed:

The Engineering Council understands its field of activity to be approximately as follows: (1) Council may deal with any matter of general interest for which joint action of two or more of its member societies would have been appropriate if Council had not been established. (2) Council may initiate and carry through projects of the general character defined in the bylaws, for which the necessary financial provision has been made; but Council shall not undertake expenditures in excess of appropriations for its uses made by the United Engineering Society on behalf of the Founder Societies and the contributions from other member societies, unless specific provision shall have been made therefor by subscription, donation or otherwise; moneys received by Engineering Council shall be turned into the treasury of United Engineering Society and disbursed by it, for the purposes designated. (3) Council may take up, and in its discretion act upon any matter of general interest referred to it by any member society or by any other society, national, state or local, or any branch of Government, or by any individual or group of individuals.

It was further resolved "that Engineering Council will as a rule avoid considering any matter which is specifically within the province of only one member society and not of the other."

A letter was addressed to President Wilson on Nov. 15 by J. Parke Channing, in which he said in part:

I am advised that you have under consideration the appointment of a Reconstruction Commission to develop a comprehensive program for the Nation's conversion from a war to a peace basis.

As chairman of Engineering Council, I respectfully ask that you consider the appointment of at least one engineer upon this commission, basing my recommendation upon the fact that all construction and practically all manufacturing is under the management of engineers.

Under date of Nov. 20 the following reply was received from the White House:

My dear Mr. Channing: I have your letter of Nov. 15, which Mr. Rickard has been kind enough to hand me. You may rest assured that I realize what a service engineers can render in reconstruction problems from time to time. We are handling reconstruction questions just now by a process of consultation between existing instrumentalities, which I hope will prove useful and effective. Cordially and sincerely yours, Woodrow Wilson.

It was voted to abolish the War Committee of Technical Societies, and the chairman and members of the committee were thanked for their patriotic service.

New Jersey Engineer Celebrates Ninetieth Birthday

Passaic, N. J., Association of the National Association of Stationary Engineers, celebrated the 90th anniversary of John Oakley, the father of Charles Oakley, well known in N. A. S. E. circles. The elder Mr. Oakley, who certainly looks as though he would live to pass the century mark, is a veteran of the Mexican and the Civil wars. The party in his honor, given Saturday evening, Nov. 30, was suggested by his grandson, Captain Oakley, who commands a machine-gun company which has seen much fighting service on the Western Front.

Among the speakers were National Vice President John J. Calahan, Past State President John J. Reddy and George R. Starr, of the Paterson, N. J., Board of Education.

Charles H. Bromley, associate editor of *Power*, reviewed the progress of steam engineering during Mr. Oakley's lifetime. Mr. Bromley said in part:

You quickest get an idea of the progress made in steam engineering in Mr. Oakley's lifetime when you realize that about the time he was born the highest steam pressure generally used on land or sea was 10 to 20 lb. Watt's first engine was patented Jan. 5, 1769, only 57 years before Mr. Oakley was born, and Watt died but 11 years before Mr. Oakley was born.

Hornblower brought out the first compound engine in 1781, but it was not patented until 1804, when it was patented by Wolf, he adapting it to high pressures. This was but 24 years before the birth of the venerable gentleman who is your guest tonight.

The Sickles drop cutoff was not introduced until 1841, or 13 years after the birth of Mr. Oakley. When Corliss first made his great improvements to the steam engine Mr. Oakley had become a voter—had reached the age of 21.

The Locomotive — Trevithick and Vivian built the first locomotive in 1804, only 24 years before Mr. Oakley was born, and he was a year old when the first locomotive was operated in the United States. The railroad was between Carbondale and Hornsdale, Penn. He was 28 years old when Horatio Allen built the first eight-wheeled locomotive, or what was the type that was the forerunner of the locomotive of today.

Steamboats—The first steamboat was run on the Seine by the Comte d'Auxiron and M. Perier in 1774. It was only 21 years before Mr. Oakley was born, or in 1807, that Robert Fulton first ran the famous "Clermont" up the Hudson.

Col. John Stevens, of Hoboken, made the first application of twin screw propellers in 1805, although it was not until 1836, or eight years after Mr. Oakley was born, that Capt. John Ericsson first made wide use of the twin screw.

The Surface Condenser—The modern surface condenser was not brought forth by Hall until 10 years after Mr. Oakley's birth, or in 1838. This development enabled higher steam pressures to be safely carried in boilers aboard ship, as it avoided the deposition of the calcium chloride in the boilers.

Steam Turbines — Parsons took out his first patent in 1884, or six years after Mr. Oakley had passed the half-century mark. De Laval did not apply for his British patent until 1889, 61 years after Mr. Oakley's birth.

Mr. Oakley was 73 years old when the first impulse turbine was commercially run in the United States, and 74 when the first Parsons turbine was run here. Speaking of turbine development, it is of interest that Tournaire, a French mining engineer, gave a theoretical description of a reaction turbine with multiple wheels—in other words, of a turbine of the modern Parsons type—to the Academy of Science in 1853.

Some great men in steam engineering who have lived and died since Mr. Oakley's birth are: Admiral Isherwood, Henry Worthington, E. D. Leavitt, George Corliss, George Westinghouse, Edwin Reynolds, Henry Stott, Professor Thurston and John Sweet.

A cake, bearing 90 candles and made by Mr. Oakley's granddaughter, was served.

The business men of this country must see to it that employment is provided for our war workers and returning soldiers. We have shown our service stars and worn our Liberty Loan buttons with pride. Let us take equal pride in doing our share to make employment for the men who have worked and fought to win the war.—*Thomas A. Edison.*

Fuel Conservation Reports to the Management*

By JOSEPH G. WORKER

Manager, Stoker Section, Westinghouse Electric and Manufacturing Company

TWO kinds of reports are generally made by engineers. The first is a report dealing in generalities, or giving information as to the character of the equipment and methods of operation. This report follows closely the standard questionnaire used by the United States Fuel Administration in which questions like the following are asked: "Total coal used per shift?" "What provisions are made for heating feed water?" "Are draft gages used?" An analysis of such reports by nontechnical men does not mean much, for the reason that they do not open up a way for the plant management to go about remedying wasteful conditions.

The second kind of report is one that deals with facts as to conditions found, and supplemented in each case by a remedy. For example, a report of the first kind might state: "The draft of No. 1 boiler is not sufficient for the coal that is to be burned." On the other hand, the second kind of report would state: "The draft in the furnace of No. 1 boiler is 0.2 in., and on the boiler side of the damper, it is 0.8 in., a drop of 0.6 in. through the boiler. This draft loss is too high. Upon further investigation soot accumulation on the tubes was found to restrict the third pass, and this soot accumulation should be removed at once." It is the engineer's responsibility to get facts to the management in such a way that it may know what must be done to remedy troubles.

It is not uncommon for operating engineers to make the statement that they were unable to do anything constructive because the management did not provide them with the necessary means. In cases of this kind one will find that the responsibility is strictly up to the operating engineer. Nowadays one cannot expect to get very far without making a clear analysis of his problems and presenting facts in such way as to force a decision. A management is not going to spend money just because it is another's idea that the expenditure will remedy difficulties. If a plant is in bad condition and an engineer takes the job of cleaning it up, it might be three or four years before he could finally obtain all the things required to make the plant right. One cannot do these things in a hurry, and one must obtain real facts to present to the management before one can expect their endorsement of one's views.

An abstract of a report recently made of a plant which reported to the Fuel Administration that "they were unable to save coal on account of the bad condition of the fuel-burning equipment" may be of interest as showing how facts, with remedies, can be reported.

After an inspection of conditions at this plant, I have no hesitancy in recommending the following, but include substantiating evidence and facts:

1. *Draft.*—I took the following draft readings in the breeching: Draft in flue over No. 1 boiler, 0.63 in.; over No. 4 boiler, 0.70 in.; over No. 6 boiler, 0.53 in.; over No. 8 boiler, 0.34 in. Draft readings in the several furnaces were taken but were discarded as worthless on account of the poor condition of the baffles, and accumulation of soot. As a matter of record, however, they are as follows: No. 1, 0.25 in.; No. 2, 0.25 in.; No. 3, 0.30 in.; No. 4, 0.20 in.; No. 5, 0.20 in.; No. 6, 0.12 in.; No. 7, out; No. 8, 0.25 inch.

2. I would recommend that flue-neck connection to all boiler damper boxes be made air-tight, so flue expansion strains will not disrupt the brickwork around them. This can be done by fastening angle irons on the flue neck on a line where it will come in contact with the damper box, and building an air seal with dry, powdered asbestos. The necessity of the above is shown by the conditions of the brickwork and excessive air leaks at this point on all boilers.

3. Rebuild the boiler settings so they will be tight. In some cases, this will probably mean rebuilding the entire setting. On some boilers where the draft is poor, gas can be seen leaking out through cracks at the top. In this reconstruction, firebrick linings should be tied to common brickwork. The stoker arch should be independent of the Stirling arch. The relieving arch should be provided to carry the front wall, and firebrick around the furnace doors should be built to protect frames. Also, each ashpit should be built to provide more capacity, with clearance in rear of the dumps.

4. Refit all boiler inspection doors and provide latches so that they will be tight. At present this is one of the main sources of air leakage on all boilers.

5. Thoroughly remove scale from the drums, tubes and circulators; No. 7 was the only boiler I had a chance to inspect for scale, and it is in a deplorable condition. In the rear drum there were many tubes where water would not pass through. The steam circulators in No. 7 have at least ¼-in. scale.

6. Scrape and brush all soot and scale accumulation from the external surfaces of tubes and drums. I have found no record when this was last done. On no boiler that I examined did I find less than ¼ in. of such accumulation, and on the back of the first-pass tubes over the baffle on No. 7, this was as deep as 3 in. In this same boiler soot was piled fully 6 feet.

7. Make the baffles tight, especially where they come in line with the inspection doors. No. 7 boiler has *no rear baffle*. The first baffle is also full of holes. No. 5, another boiler I inspected, also had leaky front and rear baffles. At present, draft readings are worthless because of the condition of the equipment, but after the baffles are repaired, I recommend that a series of draft readings be taken to see if the draft losses through the boilers are as they should be.

8. The feed-water and steam lines should be covered, and steps taken to stop excessive steam leaks.

9. Give attention to boiler blowoff valves, first to prevent leaks, and second to facilitate operation, so it will not be necessary to use a 4-ft. pipe on the wrench handle as is now the case.

A review of this report will show that the engineer obtained facts as to the condition of this plant. The merit of the report is that it can be handed to any management, and even if the facts are disputed, they can be established, and then it is only a question of what is to be done.

Although we are told that the savings in power-plant operation are to be made in the boiler room, it is seldom that a distinction is made between the economic possibilities due to supervision, equipment and methods of operation. These are three distinct problems, and there can be no question but what those of supervision and methods of operation are the most important at this time. The waste of fuel is more pronounced in small plants, due, not so much to the equipment, as to the supervision and methods of operation. In order to obtain facts in regard to boiler-room operation, the operators must be trained in the combustion of fuel. It is understood that the United States Fuel Administration is contemplating an elaborate educational program as a part of the work of the Bureau of Conservation. If done it will be the biggest thing done by the Fuel Administration.

This plan of building up the standard of intelligence in the boiler room does not mean that one must go out and find combustion experts. A good combustion operator need not be highly technical. Experience has shown that the practical man, with the proper training, is the best man for the job. Statements have frequently been made that certain ends can be attained in operation and economy by experts. An analysis of such an organization will show that these experts were at one time in the boiler room firing coal.

If the 34,000,000 tons of coke that was made in beehive ovens in the year 1917 had been made in the byproduct type, approximately 750 million cubic feet of gas would have been saved, according to estimate, every 24 hours. From this gas about 65 million gallons of benzol might have been recovered.

*From a paper entitled "Fuel Conservation—Responsibility of the Engineer and the Management," read before the Station Operating Committee of the Ohio Electric Light Association, Cincinnati, Ohio.

Chicago Conservation Meeting

On Monday evening, Nov. 25, the eight societies of the War Committee held a joint meeting on conservation. This gathering had been postponed from an earlier date, but as there is still need of conservation during the coming winter, the subject has current value, and many interesting facts were brought out by the speakers of the evening. The meeting was particularly well attended, filling the quarters of the Western Society of Engineers to overflowing.

As an introduction, two reels of the Ford moving picture, "Coal is King," were shown. These pictures gave visual evidence of the amount of coal required to make shells, ships and a variety of war products. They also showed how coal is mined, and included specific examples of how coal may be conserved in the power plant. The removal of soot by the mechanical blower was pictured on the screen; data were given showing the importance of keeping the heating surface free from scale and the covering of all surfaces that might radiate heat. The series also contained pictures showing how leakage may be detected in steam traps and boiler blowoff valves.

Prestons Millar, general manager of the Electrical Testing Laboratories, New York, spoke on "Lighting in War Time," giving in detail the work of the committee on war service of the Illuminating Engineering Society. He outlined the organization of this committee, and reviewed the work conducted throughout the war period. His remarks were divided into four subjects as follows: "Promotion of production by improved lighting"; "Protection of important properties"; "Safety"; and "Lighting of the field in which conservation might be conducted." He said that statistics are now available to show that by replacing old systems of lighting with modern intense lighting, it is possible to increase production from 30 to 100 per cent. The direction and the diffusion of the light are as important as the intensity, these factors calling for new types of reflectors and improved methods of arranging and placing the lights.

Protective lighting of important buildings serves as a potential for good defense. With plenty of light surrounding the building, effectual guarding may be accomplished with a less number of guards.

As to the promotion of safety, improved lighting would reduce accidents. Statistics show that 18 per cent. of the industrial accidents today are due to improper lighting. As a consequence the services of 108,000 men per year are lost to the country. In war time this factor is of great importance, and from the humane standpoint the subject is worthy of every attention that can be given it.

Recently the committee has been engaged in making a survey of coal mines, with a view to improving the lighting, and thereby increasing the production.

As to conservation in the field, the possibilities are not great, as electric lighting is responsible for only 2 per cent. of the coal used in the country. Curtailment of the size or number of lights seems to be unwise, as it results in more accidents, and tends to reduce, rather than increase, production in the commercial field, so that indiscriminate curtailment should not be considered. The psychological effect of burning lights in public parks, in advertising signs, show windows, etc., is a factor, however, that should not be overlooked. Substituting new lights for less efficient lamps, such as the new mazda for the old carbon incandescent lamp, using better reflectors, directing the light properly, and getting the best diffusion possible, are all factors by which a saving can be made.

Toward the elimination of waste the most striking thing that has been done by the committee is a recommendation that certain sizes and types of lamps that are inefficient should be eliminated. In this direction, the various public utility companies have shown progress, so that efforts should be directed toward certain manufacturing interests.

From its varied experience since war was declared, the committee eventually decided that best results from all standpoints would be obtained by basing their work, first, on the promotion of the war ability of the nation; second, on public welfare; third, on conservation of the lighting industry; and fourth, on conservation of other industries.

Harold Almert, director of conservation for the State of Illinois, talked in detail on the organization that had been perfected. He outlined the various branches of the conservation department, and commented briefly on the work of each. Although the fuel situation in Illinois is in excellent condition, the country, as a whole, is still short of coal, so that the activities of the Fuel Administration must be continued for the present season at least. The signing of the armistice should not be taken as an indication that all efforts toward conservation should cease. The work has already resulted in a great deal of good, and should be continued.

George O. Kaley

Brooklyn Association No. 8, of the N. A. S. E., has sustained an irreparable loss in the death of George O. Kaley, who died suddenly on Friday morning, Nov. 29, following an attack of acute indigestion, at the Brooklyn Naval Branch of the Y. M. C. A., of which he had been chief engineer for the past twenty years. He was born in Albany, N. Y., and was 61 years of age.

Mr. Kaley was a charter member and past president of Brooklyn, No. 8. He was past president of the New York

GEORGE O. KALEY

State Association of the N. A. S. E., and one of the organizers of Melville Council, No. 9, U. C. C. of E. He was also a member of Damascus Commandery No. 58, Knights Templar, and of Kismet Temple, A. A. O. N. M. S., and of the Loyal Order of Moose, No. 14.

He was always greatly interested in the educational work in the engineering field, and had the happy faculty of balancing the social and fraternal features. He leaves a host of friends, and will long be remembered for his kindly interest in the uplift and advancement of the engineer and for his eagerness to promote a spirit of true fraternalism among his brothers everywhere.

The funeral services were held on Sunday afternoon in the Operating Engineers' Building, 125 South Elliott Place, Brooklyn, and were conducted by the Order of Masons and the Order of Moose. The interment was at Albany on Monday afternoon. Mr. Kaley is survived by a daughter, Mrs. Walter Sharp, and a son George, who is a lieutenant in the U. S. Army.

Power shortage in the Kanawha, New River and Winding Gulf, W. Va., coal regions will be remedied when the Virginia Power Co. completes the addition to its power plant at Cabin Creek Junction, now under way, the new machine being capable of generating 20,000 kw. With the Government plant at Nitro, as well as many of the mining plants in the regions alluded to, depending upon the present plant for power, the company is unable at times to carry the load. Of course the improvements now under way will necessitate a readjustment to some extent of the company's present transmission system.

New Publications

FUEL ECONOMY IN BOILER ROOMS

In the review in the Oct. 29 issue of the book "Fuel Economy in Boiler Rooms," published by the McGraw-Hill Book Co., the price of this book was stated as $2.25. The correct price of the book is $2.50.

Obituary

Martin W. Kern, who was mechanical engineer of the Narragansett Electric Lighting Co., Providence, R. I., for the last ten years, died recently. Mr. Kern was formerly connected with the Rhode Island Co. at Providence and was with Stone & Webster at Boston for several years.

Arthur M. Reed, aged 40 years, an engineer at the gas plant of the South Penn Oil Co., at Pigear, Elk Co., Penn., met a tragic death on the night of Nov. 25. Reed's clothing caught in the shaft as the body whirled about it, striking against an iron railing, tearing off both arms and legs and mangling the body horribly. The body whirled about the shaft until all clothing was torn off.

Personals

Harry Himelblau has been appointed mechanical engineer in charge of power-plant operation for the Armour Grain Co., Chicago, Ill.

A. Balmfrith, formerly superintendent of McGill University power plant, is now chief engineer for the Northern Products Co., Ltd., Montreal, Canada.

L. C. Sprague has been appointed assistant secretary of the Chicago Pneumatic Tool Co., with headquarters at 52 Vanderbilt Ave., New York City.

Harry Curran, who has long been an active member of the Marine Engineers' Beneficial Association of Portland, Me., has recently joined partnership with S. R. Stockholm, and they have organized under the firm name of the Maine Electric Welding Co., 21 Custom House Wharf, Portland, Me.

Engineering Affairs

The American Institute of Electrical Engineers will hold its 342nd meeting at Philadelphia, Dec. 13-14, under the auspices of the Philadelphia Section. The headquarters will be at the Clover Room of the Bellevue-Stratford Hotel.

Phoenix Association No. 24, N. A. S. E., New York City, held the third of its lesson sessions on Furnace Efficiency Tuesday evening, Nov. 26. Charles J. Mason, past president, is conducting the association through these interesting lessons.

The San Francisco Section of the A. S. M. E. will hold a meeting on Dec. 19. The subject will be: "Why Is the Internal-Combustion Engine Not Used More Extensively for Marine Propulsion?" The speakers will be J. H. Hanson, president of the Scandia Pacific Oil Engine Co., and Bruce Lloyd, of the United States Shipping Board.

Huntington Association No. 3, N. A. S. E., held a lively session Monday night, Nov. 18, at which plans were discussed and preliminary organization perfected for the biggest convention event in the history of Huntington, W. Va.—the meeting of the association next September. The meeting was in the nature of a smoker, which was thoroughly enjoyed by all. The following committee on entertainment for the national association meeting was named: A. R. Hetzer, W. P. Yates, C. L. Humphreys, R. C. Flaugher and James S. Fields.

The Consolidated Marine Engineers' Beneficial Association, No. 33, held its entertainment and ball on Wednesday, Dec. 4, at the Central Opera House, New York City. There was the usual big attendance, among them being many prominent persons in the engineering field, including several officers of the Army and Navy. A pleasing vaudeville entertainment preceded a long dancing program. At the close of the entertainment, T. L. Delahunty, the business manager of the organization, introduced P. H. W. Ross, president of the National Marine League of the United States of America, incorporated under a perpetual charter in Washington, D. C., in the year 1913. Mr. Ross spoke for ten minutes on the "Promotion of the American Merchant Marine." The event proved a social and financial success.

Dinner to John J. Calahan—About 100 friends attended a complimentary dinner to John J. Calahan, national vice president of the National Association of Stationary Engineers at the Marlborough Hotel, New York City, Saturday, Nov. 23. John J. Reddy was toastmaster. Among the speakers were: William J. Reynolds, chairman of the Board of Directors of the National Association of Stationary Engineers; George R. Starr, of the Board of Education, Paterson, N. J.; J. B. Taylor, secretary of the Life and Accident Department of the National Association of Stationary Engineers; James S. Heath, president of the New Jersey State Association, N. A. S. E., and Charles H. Bromley, associate editor of *Power*. Between the speeches the diners were entertained by Bob Jones, of France Packing Co.; Billy Murray, of Jenkins Bros., and Jack Armour.

Visits of New Jersey N. A. S. E.—The third of the yearly visits of the state officers and visiting committees of the associations of the National Association of Stationary Engineers in New Jersey was held in Newark, Nov. 25. John J. Calahan, national vice president, is chairman of the visiting committee for the association, and J. W. Wilson, of the Dearborn Chemical Co., is chairman of the Supply Men's Committee, which participates in the arrangement of visits. The other visits for the winter are: Dec. 6, Perth Amboy, Redman's Hall, Smith St.; Dec. 22, Hoboken, Odd Fellows' Hall, 412 Washington St.; Jan. 3, Plainfield, 109 Park Ave.; Jan. 15, Bayonne, Hendrickson's Hall, Broadway and 31st St.; Jan. 25, Atlantic City Association; Feb. 8, Phillipsburg, Pennsylvania Railroad Building; Feb. 22, Passaic, Post Office Building; Mar. 7, Trenton, 219 East 8th St.; Mar. 19, Elizabeth, Eagle's Hall. A. D. Mencke is state secretary with offices at 122 Milford Ave., Newark, N. J.

Miscellaneous News

Dr. Garfield Resigns—The resignation of Dr. Harry A. Garfield as Federal Fuel Administrator has been accepted by President Wilson, but no announcement has been made as to its effective date. "The Fuel Administration will continue to operate at least until the end of the present winter and it will continue control of the anthracite supply."

Bituminous Coal Production and distribution have reached such a satisfactory point in relation to demand that the Fuel Administrator is contemplating the possibility of abolition of all price and zone restrictions Dec. 15. Anthracite distribution remains a problem that will require the active attention of the Administration for an indefinite period. Other branches will so far have completed their work by Jan. 1, that probably only a nucleus of their organizations will be necessary after that date.

Business Items

The Sanford Riley Stoker Co. and Murphy Iron Works will combine their sales policies on Jan. 1, so as to render the greatest possible service to all customers. Offices will be located at the following places: Worcester, Cleveland, Boston, Detroit, New York, Cincinnati, Philadelphia, Chicago, Pittsburgh, St. Paul, Buffalo.

The Walter A. Zelnicker Supply Co., St. Louis, announces the appointment of Joseph Meyerson as secretary to the president. Mr. Meyerson was associated for ten years with the Southwestern Tariff Bureau. Mr. Kottsieper, who for many years traveled for the St. Louis Screw Co., has recently joined the traveling force of the company and will make southwestern territory.

Trade Catalogs

The D. Connelly Boiler Co., of Cleveland, Ohio, has just issued a catalog containing descriptions of the Connelly water-tube boiler and illustrations of installations. This should be in the file of every power-plant engineer, especially those who are interested in large boiler units.

New Construction

PROPOSED WORK

R. I., Phillipsdale—The American Electrical Works has had plans prepared for the construction of a 1-story, 20 x 20 ft. centrifugal pump house with an intake of 300-ft. x 30-in. pipe.

N. Y., Brooklyn—The Board of Education, 500 Park Ave., New York City, will install steam heating systems in the following schools which it plans to build: P. S. 29, 5-story, 118 x 192 ft., on Henry and Harrison St.; estimated cost, $543,474; P. S. 182, 5-story, 118 x 192 ft., on Dumont Ave. and Wyoma St., $453,474; P. S. 100, 4-story, 100 x 144 ft., on West 1st St., Coney Island, $295,500; P. S. 144, 5-story, 105 x 127 ft., on Howard Ave. and Prospect Pl., $298,000; P. S. 73, 4-story, 59 x 100 ft., on Sumpter St. and Rockaway Ave., $210,000; P. S. 80, 4-story, 100 x 144 ft., on West 19th St., Coney Island, C. B. J. Snyder, Municipal Bldg., New York City, Arch.

N. Y., Garretson (Staten Island P. O.)—The Board of Education, 500 Park Ave., New York City, will install a steam heating system in the 1-story, 103 x 140 ft. school which it plans to build here. Total estimated cost, $90,000. C. B. J. Snyder, Municipal Bldg., New York City, Arch.

N. Y., New York—The Board of Education, 500 Park Ave., will install a steam heating system in the 5-story, 98 x 157 addition to P. S. No. 130 on Baxter St. Total estimated cost, $506,592. C. B. J. Snyder, Municipal Bldg., Arch.

N. Y., New York—The Board of Education, 500 Park Ave., will install a steam heating system in the 5-story, 118 x 192 ft. school which it plans to build on Crotona Ave. and 181st St., Bronx Boro. Total estimated cost, $543,474. C. B. J. Snyder, Municipal Bldg., Arch.

N. Y., New York—The Board of Education, 500 Park Ave., New York City, will install a steam heating system in the 3-story, 59 x 100 ft. addition to P. S. No. 43, on Brown Pl., Bronx Boro. Total estimated cost, $93,250. C. B. J. Snyder, Municipal Bldg., Arch.

N. Y., Niagara Falls—The Hydraulic Power Co. has applied to the Public Service Commission for permission to issue $2,000,000 bonds for extensions and improvements to its plant.

N. J., Jersey City—The City Commission has made an appropriation of $200,000 for the construction of a power plant for the Lincoln school, also new boilers and auxiliary equipment at the Cole St. bathhouse and for a new boiler at the City Hospital.

N. J., New Brunswick—The Board of City Commissioners has had plans prepared for the construction of a new boiler house at Weston Mill Pond for the municipal water-works.

Penn., Elkton—A. J. Reach & Co., Tulip and Palmer St., Philadelphia, plans to build a 1-story boiler plant at its works here.

Penn., Lucinda—The Lucinda Coal Co. plans to build a new power plant.

Penn., Philadelphia—The Barrett Manufacturing Co., West 36th St. and Grays Ferry Rd., plans to build a 1-story, brick and concrete pumping plant.

Md., Baltimore—S. T. Williams, 223 North Calvert St., is in the market for 300-350 h.p. engines.

Md., Indianhead—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install boilers and superheaters in the Navy Yard here; Specification No. 3707. Estimated cost, $55,000.

Md., St. Helena—The Dunkalk Co. plans to build a pumping plant. Estimated cost, $25,000. Norton, Bird & Whitman, 1320 Munsey Bldg., Baltimore, Engr.

D. C., Washington—The Bureau of Yards & Docks, Navy Department, will receive bids until Dec. 19 for furnishing motor generator set, transformers, air compressors, motors, controllers, tanks, air pumps, and motor control switches; Specification No. 3607.

Va., Richmond—Hackley Morrison, 204 Moore Bldg., is in the market for an 8 or 10 ton, 4 wheel, saddle-tank locomotive, 42-in. track gage.

W. Va., Affinity—The Pemberton Coal & Coke Co. plans to build an electric power plant and is in the market for boilers and generator.

W. Va., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install boilers and superheaters in the Navy Yard here; Specification No. 3707. Estimated cost, $120,000.

W. Va., Hartland—The Hartland Power Co. plans to extend the Elk River transmission system to furnish electricity to three coal mining companies.

W. Va., Webster Springs—The Webster Springs Water & Electric Light Co. plans to build an electric-light plant.

W. Va., Windsor—The Wheeling Electric Co., Wheeling, subsidiary of the American Gas & Electric Co., 30 Church St., New York City, N. Y., plans to construct a new steam operated electric power plant here. Estimated cost, $1,000,000.

N. C., Statesville—J. C. Steel & Sons are in the market for engines and boilers.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install boilers and superheaters in the Navy Yard here; Specification No. 3707. Estimated cost, $50,000.

S. C., Elloree—The Elloree Electric Light Co. plans to rebuild its plant recently destroyed by fire and will install new machinery.

Miss., Tutwiller—The city voted $8000 bond issue for the construction of a municipal electric light plant. Address the Mayor. Noted Nov. 26.

La., New Orleans—The New Orleans Boiler Works plans to enlarge its boiler works and install additional machinery.

La., New Orleans—The Weil Electric Works, Inc., 821 Perido St., is in the market for two 100 kw. generators with switchboard, or one 200 kw.-a.c. 3-phase 2200-volt direct connected 60-cycle alternator, driven by crude oil engine; three 50 hp. vertical motors; 6 h.p. vertical motors; all for above generator; also for horizontal motors if no vertical motors are available, or belt-driven alternators and belted engines if no direct connected ones are available.

La., New Orleans—The Machinery Exchange Co., Bienville and David St., is in the market for two or more turbine driven generators, 1000 to 1500 kw.

Ohio, Akron—The Quaker Oats Co., Mill and Howard St., will install a steam heating system in the grain plant which it plans to build. Total estimated cost, $150,000.

Ohio, Cleveland—The U. S. Copper Co., Guardian Bldg., will install a steam heating system in the copper and brass mill which it plans to build. Total estimated cost, $100,000.

Ind., Fort Wayne—The Pennsylvania Lines West of Pittsburgh, Union Station, Pittsburgh, Penn., will install a steam heating system in the 1-story, 30 x 240 ft. machine shop and the 108 x 400 ft. locomotive repair shop, which it will build here. Total estimated cost, $100,000 and $150,000, respectively.

Mich., Flint—The Board of Education will install a steam heating plant in the 2-story high school which it will build. Total estimated cost, $600,000. Malcolmson & Higginbotham, 404 Moffat Bldg., Detroit, Arch.

Mich., Saginaw—R. F. Johnson, Comr. of Light, Water and Sewers, submitted report to city, estimating cost of installing auxiliary pumping equipment in West Side pumping station and laying new mains to handle water supply, at $25,000.

Wis., Superior—The Globe Shipbulding Co., 1737 Broadway, plans to build a steam generating plant. Estimated cost, $25,000.

Wyo., Torrington—The city will soon award the contract for the construction of an electric-light system, and is in the market for sub-station equipment for connecting government lines with light plant, also may purchase a 100-h.p. engine. Noted Dec. 3.

Mo., Altenburg—The Altenburg Light & Power Co. plans to rebuild its electric light plant recently destroyed by fire, and is in the market for $10,000 worth of machinery.

Mo., Humansville — The Humansville Electric Light Co. plans to construct an electric transmission system from Caplinger Mills to Stockton, about 8 miles. L. L. Mathis, Secy.

Tex., Bay City—The Bay City Utilities Co. has been incorporated with $40,000 capital stock for the purpose of installing water-works and electric-light plants. W. H. Caldwell is interested.

Tex., Burkburnett—The Central Power & Service Co. plans to build a steam power plant.

Tex., Houston—The City Council is having plans prepared by E. E. Sands, City Engr., for the installation of deep-well pumps, motors, electrical generators, etc., at the central water plant.

Tex., Orange—The National Shipbuilding Co. will equip an electric power plant at its yards.

Okla., Okmulgee—The city plans extensive alterations and enlargements to its ice and electric light plant. Estimated cost, $125,000.

Okla., Sulphur—The city plans to erect a power house at the pumping station. Address the Mayor.

Wash., Puget Sound (Bremerton P. O.)—The Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will soon award the contract for furnishing and delivering under Schedule No. 7346½, one 28 h.p. motor; Schedule 7348½, one 50 h.p. motor.

Cal., Los Angeles—The Board of Public Service, 645 South Olive St., will receive bids until Dec. 20, for furnishing sheet steel rivets and pipe sections for pipe line and penstocks for power plant No. 2 in San Francisquito Canyon. Estimated cost, $75,000. W. Mulholland, 645 South Olive St., Engr. Noted Dec. 3.

Cal., Martinez—The City Trustees will receive bids until Dec. 16 for building 1,500,000 gal. reservoir, 18 x 24 ft., pump house, steel stand pipe, 50 ft. high, 2 ft. diameter, 2 triplex pumps, having 270 gal. capacity per minute and two 25 hp. motors. Olmsted & Gillelen, 1112 Hollingsworth Bldg., Los Angeles, Engr.

Cal., Oceanside—The Board of Trustees plans to construct an electric power plant for its waterworks system, to have a pumping capacity of about 45,000 gal. per hour.

Ont., Toronto—W. H. Banfield & Sons, Ltd., 372 Pape Ave., is in the market for a motor generator, 25 cycle, 2 to 3 kw. capacity.

Man., Mapleton—The Manitoba Steel Foundry Co. plans to build a 1-story power house. Estimated cost, $10,000.

B. C., Jedway—The Producers Mines, Ltd., plans to build a power plant at its mines near Jedway. Frank Buckingham, Supt.

B. C., New Westminster—P. Bain, 113 5th Ave., is in the market for a stationary gasoline engine, 20-25 h.p.

CONTRACTS AWARDED

Conn., Hartford—The Knights of Columbus, 26 Chapel St., has awarded the contract for the installation of a steam heating system in the 3-story, 32 x 100 ft. club house, to J. B. Beegan, 952 State St. Total estimated cost, $50,000.

Conn., Stamford—The Waterside Mills, Pacific St., will rebuild its plant and power house, recently damaged by fire. Estimated cost, $50,000. Noted Nov. 12.

Ohio, Bradford—The Pennsylvania Lines West of Pittsburgh, Pennsylvania Station, Pittsburgh, Penn., has awarded the contract for the construction of a 1-story engine house annex, power house, oil house, sand house and storage buildings here, to the H. W. Evans Co., Columbus Savings & Trust Bldg., Columbus. Estimated cost, $250,000.

Ohio, Cleveland—The Pennsylvania Lines West of Pittsburgh, Pennsylvania Station, Pittsburgh, Penn., has awarded the contract for the construction of a 1-story, 110 x 130 ft. round house addition here, to the Crowell, Lundoff & Little Co., Merian Bldg. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Columbus—The Pennsylvania Lines West of Pittsburgh, Union Station, Pittsburgh, Penn., has awadred the contract for the construction of a 32-stall engine house addition, car shop, oil house, power house, sand house, fan house and 4 storage buildings, on Denison Ave., here, to G. A. Fuller, 404 Swetland Bldg., Cleveland. Estimated cost, $500,000.

Ont., London—The Department of Public Works, Ottowa, has awarded the contract for the installation of a heating system in the soldiers' hospital, to A. E. Ponsford, St. Thomas, and is in the market for 7 large boilers and general equipment.

N. B., St. John—The Department of Public Works, Ottawa, Ont., has awarded the contract for alterations and additions to the power plant, to F. S. Walker, 14 Church St.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$6.55	$7.30	Broken	$7.80	$8.55
Buck.	5.10	5.90	Egg	7.70	8.45
Rice	4.65	5.10	Stove	7.95	8.70
Barley	4.15	4.30	Chestnut	8.05	8.80

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b., Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$4.80	$3.40	$6.05	$4.30
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.50
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70

Climax seam near Maylene.

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10

other rates p. 95.